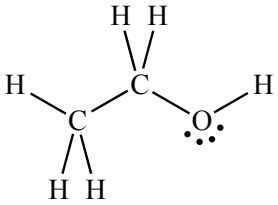
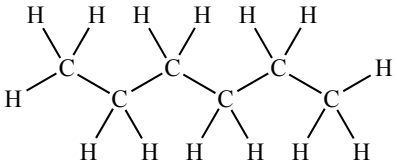
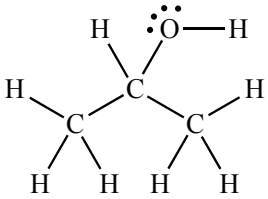
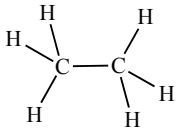
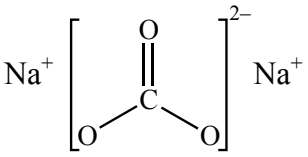
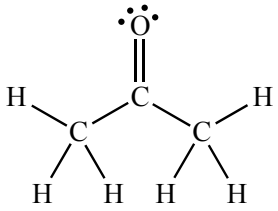
Demo [15 pts]
Conductivity, bp and mp

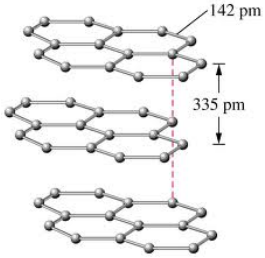
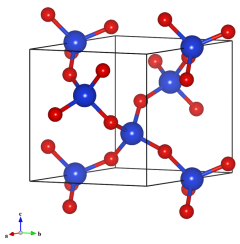
Name Answer Key
Period _____ Date _____

Introduction: To study and understand the conductivity, melting pts and boiling pts of substances.

TABLE OF ALL THE SUBSTANCES IN THIS LAB:

POLAR COVALENT MOLECULAR	NON POLAR COVALENT MOLECULAR	IONIC	METALLIC
ethyl alcohol mp = –117.3°C bp = 78.5°C 	**Hexane** mp = –95°C bp = 69°C 	**NaCl** (Sodium Chloride) mp = 800°C Na^+ Cl^-	**Lead (Pb)** mp = 327°C e^- e^- Pb^{+2} e^- Pb^{+2} e^-
isopropyl alcohol mp = –89.5°C bp =82.4 °C 	**ethane gas** mp = –183°C bp = –88°C 	**Na_2CO_3** (sodium Carbonate) mp = 851°C 	**Copper (Cu)** mp = 1085°C e^- e^- Cu^{+2} e^- Cu^{+2} e^-
Acetone mp = –95.4°C bp = 56.2 °C 			

NETWORK COVALENT

Diamond (C)	**Graphite (C)**	**Quartz (SiO_2)**
mp = 3550°C	mp= 3500 °C	(no distinct mp)
		

PART 1: Conductivity: I will demonstrate the conductivity of each of the following substances using the light bulb set up. Record conductivities below.

lead (s) Conductive	Na_2CO_3 (s) Non	NaCl (aq) Conductive
copper (s) Conductive	NaCl (s) Non	graphite Conductive

1) Do copper and lead conduct electricity when solids? Yes Explain why or why not. *(Include a description of their general structure.)*
Metals are composed of a lattice of metal cations surrounded by a sea of delocalized electrons. These electrons are able to move throughout the structure (mobile charge carriers) and can respond to the presence of an electric field (+ & – poles).

2) Does a solution of NaCl dissolved in water, *NaCl (aq),* conduct electricity? Yes
Explain why or why not. *(Include a description of what is in the solution.)*
When an ionic compound dissolves in H_2O, the ions dissociate into individual ions (surrounded by the water hydration sphere). These separate ions can move in response to the presence of an electric field (as in #1, mobile charge carriers).

3) As pure solids, do Na_2CO_3 and NaCl conduct electricity? No
Explain why or why not. *(Include a description of what the solids consist of.)*
As solids, the ions are held strongly in position in the lattice of alternating ions by the ionic bonds (lattice energy). Electrons are localized on the ions, so there are no mobile charge carriers.

4) Would molten NaCl, *NaCl (l),* conduct electricity? Yes Explain why or why not. *(Again- describe substance.)*
Molten NaCl would contain ions that are free to move (particles in a liquid can flow) since they have partially overcome the ionic bonds, again giving mobile charge carriers that can respond to the presence of an electric field.

5) Does graphite conduct electricity? Yes Explain why or why not. *(Include a description of its structure.)*
Graphite consists of stacked planes composed of trigonal planar (sp^2 hybridized) carbon atoms in a hexagonal structure. Each C atom has an unhybridized p orbital, containing a single electron, perpendicular to the plane of the atoms. These adjacent p orbitals can form an extended π system throughout the plane, through which the electrons can travel. These electrons are mobile charge carriers that can respond to the presence of an applied electric field.

6) Diamond does **not** conduct electricity. Explain why not. (*Include a description of its structure.)*
Diamond is composed of an extended network of tetrahedral sp^3 hybridized carbon atoms. Since sp^3 hybridization does not allow formation of π bonds, all electrons are localized within σ bonds, and there are no free electrons or other mobile charge carriers.

PART 2: Range of Melting points: Look at the melting points of **ALL** the substances listed on front.

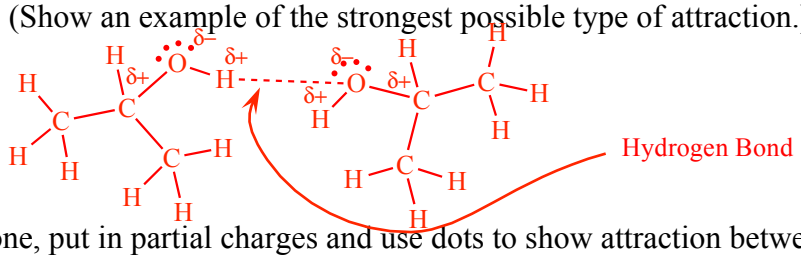
7) What is the melting point of NaCl? 800°C This is a relatively high melting point. Explain why it is so high. *(Be specific describe the attractions that must be broken and explain why they are so strong.)*
NaCl is an ionic compound consisting of alternating Na^+ and Cl^- ions held together by ionic bonds. Since ionic bonds consist of full charges, and the ions can get very close together, these bonds are very strong, and these strong bonds are what must be broken for NaCl to melt.

8) What is the melting point of lead? 327°C This is a relatively high melting point. Explain why it is so high. *(Be specific describe the attractions that must be broken and explain why they are so strong.)*
In metallic bonds, the attractive forces are between metal cations and delocalized electrons, which have full charges (and multiple electrons per cation). Again, because of the full (or more) charge, metallic bonds are very strong.

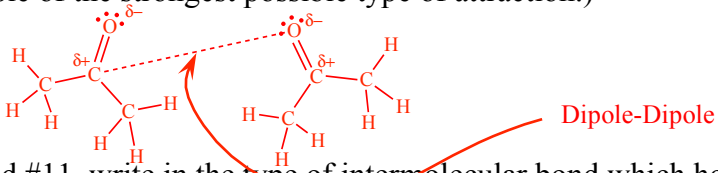
9) Give the names of the three network covalent substances listed on the front page of this demo:
Diamond (C) Graphite (C) Silica/Quartz (SiO_2)
Why do these substances have such high melting points?
They have no discrete particles but are essentially large molecules of extended covalent bonds, which are very strong and require a lot of energy (high temperature) to break.

PART 3: Boiling Point Comparisons: Look at boiling points and structures on front.

10) Draw two molecules of isopropyl alcohol, put in partial charges and use a dotted line to show an attraction between molecules (Show an example of the strongest possible type of attraction.)



11) Draw two molecules of acetone, put in partial charges and use dots to show attraction between molecules. (Again, show an example of the strongest possible type of attraction.)



12) For both of the diagrams in #10 and #11, write in the type of intermolecular bond which holds the two molecules together. Draw an arrow pointing to where that intermolecular bond is in each diagram.

13) What is acetone's boiling point? 56.2 °C What is isopropyl alcohol's? 82.4 °C
Why is acetone's boiling point considerably lower than isopropyl alcohol's?
Isopropyl alcohol contains O–H bonds that consists of a very strong dipole, which allow it to form H-bonds between molecules. Acetone has a relatively weaker C–O dipole, and forms weaker dipole-dipole attractions. The weaker attractions in acetone require less energy, hence lower temperatures, to break.

14) What is ethane's boiling point? –88 °C What is ethyl alcohol's boiling point? 78.5 °C
Why does ethane have a significantly lower boiling point than ethyl alcohol?
Ethyl alcohol has a strong permanent dipole in its O–H bond, allowing it to form strong H-bonds between molecules. Ethane is a non-polar molecule that experiences only very weak dispersion forces, which require much less energy and much lower temperatures to break.

15) What is the boiling point of hexane? 69 °C What is the boiling point of ethane? –88 °C
Why does hexane have a considerably higher boiling point than ethane? *(Be careful—both are NP)*
Both molecules are nonpolar with only relatively weak dispersion forces attracting them. However, hexane is larger with more electrons (84 vs. 18), so it is more polarizable and can form larger (temporary) dipoles than ethane. Thus, its dispersion forces are much stronger, requiring more energy and higher temperatures to break.