Unit 2 Summative Assessment Practice

Show your work for each question in the space provided. Examples and equations may be included in your responses where appropriate. For calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Pay attention to significant figures.

1. Answer the following questions about the polarity of covalent bonds.

   (a) Circle the diagram that is the more accurate representation of the polar covalent bond between phosphorus (P) and chlorine (Cl).

   $\overset{\delta+}{P}—\overset{\delta-}{Cl}$ $\qquad$ $\overset{\delta-}{P}—\overset{\delta+}{Cl}$

   (b) Justify your choice in part (a) in terms of periodic trends and relative values for electronegativity.

   (c) Circle the diagram that is the more accurate representation of the polar covalent bond between oxygen (O) and selenium (Se).

   $\overset{\delta+}{O}—\overset{\delta-}{Se}$ $\qquad$ $\overset{\delta-}{O}—\overset{\delta+}{Se}$

   (d) Justify your choice in part (c) in terms of periodic trends and relative values for electronegativity.

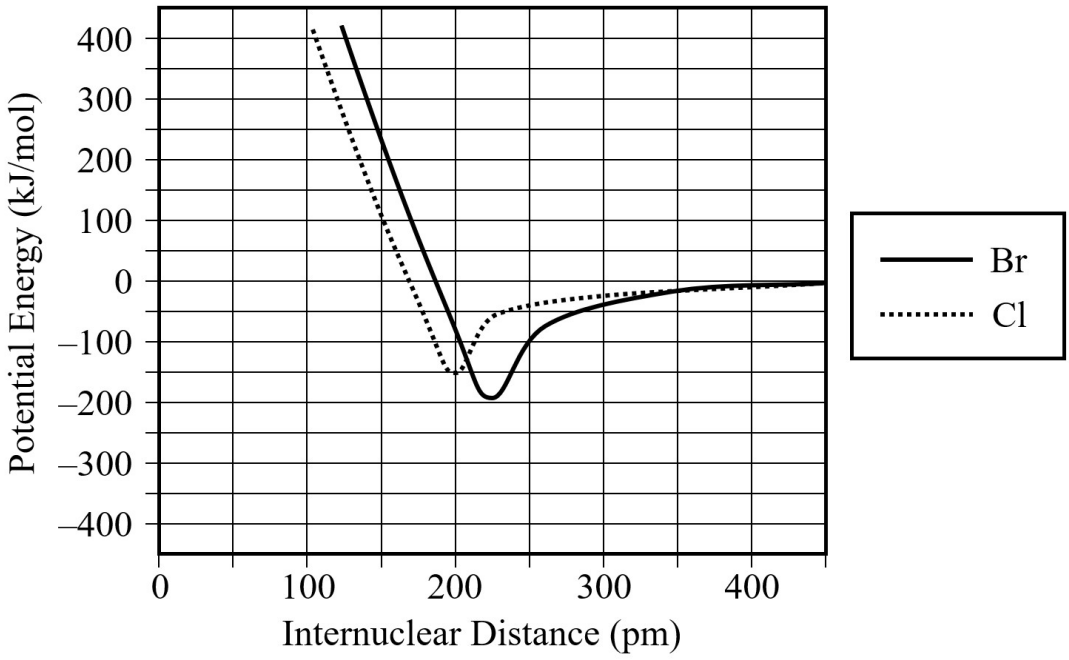
   (e) Circle the bond that has the greatest dipole moment.

   C–O $\qquad$ Ge–O $\qquad$ N–O

   (f) Justify your choice in part (e) in terms of periodic trends and relative values for electronegativity.

   (g) Circle the bond that has a dipole moment of zero.

   C–C $\qquad$ N–P $\qquad$ O–F



2. The diagram above shows the relationship between potential energy and internuclear distance. The curve for two bromine (Br) atoms is indicated by a solid line.

   (a) Use the information in the diagram to estimate the following values.

   Bond length of the Br–Br bond: _____ pm

   Bond energy for the Br–Br bond: _____ kJ/mol

   (b) Do you predict that the bond length of the Cl–Cl bond should be shorter or longer than that of the Br–Br bond? Justify your answer in terms of periodic trends.

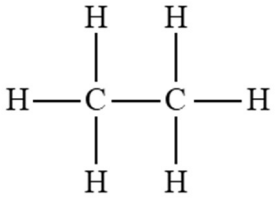
   (c) A student sketched the potential energy curve for two Cl atoms on the diagram above, as indicated by the dotted line. There is an error with the student's sketch. Identify this error, and explain how the potential energy curve should be corrected so that it would be a more accurate representation of the bond between two Cl atoms.

Appearance	red liquid
Melting point	–121°C

3. (a) Circle the chemical formula that is more likely to have the properties listed in the table above.

$CaCl_2$ SCl_2

(b) Justify your choice in part (a) in terms of the type of bonding present in each substance.



4. The Lewis diagram for C_2H_6 is shown above.

(a) Draw the correct Lewis diagram for C_2H_2.

(b) The bond energy for the carbon-carbon bond in C_2H_6 is approximately 350 kJ/mol. Do you predict that the bond energy of the carbon-carbon bond in C_2H_2 should be less than or greater than 350 kJ/mol? Justify your answer.

5. The energy required to separate the ions in the crystal lattice of an ionic solid into individual gaseous ions is known as the lattice energy. The lattice energy of NaCl(*s*) is equal to 788 kJ/mol.

Reaction	Lattice Energy (kJ/mol)
$NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$	788
$KCl(s) \rightarrow K^+(g) + Cl^-(g)$	?
$MgCl_2(s) \rightarrow Mg^{2+}(g) + 2\ Cl^-(g)$	?

(a) Do you predict that the lattice energy of KCl(*s*) should be lower than or higher than 788 kJ/mol? Justify your prediction based on periodic properties and Coulomb's law.

(b) Do you predict that the lattice energy of $MgCl_2(s)$ should be lower than or higher than 788 kJ/mol? Justify your prediction based on periodic properties and Coulomb's law.

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6. In the space below, complete the Lewis electron-dot diagram for the S_2Cl_2 molecule by drawing in all of the bonding and nonbonding electron pairs.

Cl S S Cl

(a) What is the approximate value of the Cl–S–S bond angle in the S_2Cl_2 molecule that you drew above? _____

(b) Based on your Lewis structure, identify the hybridization (*sp*, sp^2, or sp^3) of the sulfur atom in the S_2Cl_2 molecule. _____

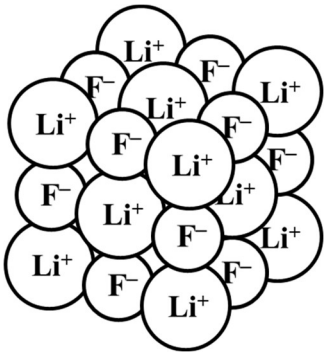
7. In the space below, complete the Lewis electron-dot diagram for the NO_2^- ion by drawing in all of the bonding and nonbonding electron pairs.

$$\left[\ \mathrm{O}\quad \mathrm{N}\quad \mathrm{O}\ \right]^-$$

(a) What is the approximate value of the O–N–O bond angle in the NO_2^- ion that you drew above? _____

(b) Based on your Lewis structure, identify the hybridization (sp, sp^2, or sp^3) of the nitrogen atom in the NO_2^- ion. _____

(c) Do you predict that the nitrogen-oxygen bonds in the NO_2^- ion should have the same length or have different lengths? Justify your answer.



8. A particle diagram is shown above that is intended to represent a portion of the crystal lattice in LiF(s). Identify an error that is shown in this particle diagram. Explain how the particle diagram should be corrected so that it would be a more accurate representation of LiF(s).

Type of Steel	% Carbon	Characteristics	Uses
Low-carbon steel	< 0.2 %	Malleable and ductile	Chains and nails
High-carbon steel	0.6 – 1.5 %	Hard and brittle	Cutting tools

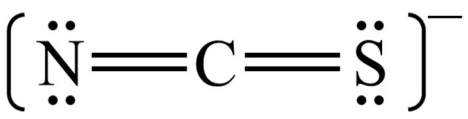
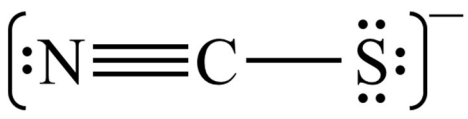
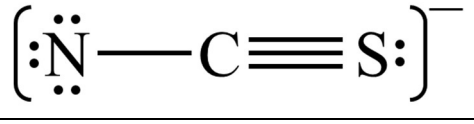
9. The table above provides some information about two types of steel, both of which are alloys of iron (Fe) and carbon (C).

   (a) Should steel be classified as a substitutional alloy or as an interstitial alloy? Justify your answer in terms of the relative sizes of the atoms of Fe and C.

   (b) Explain why high-carbon steel is more rigid than low-carbon steel.

10. Three possible Lewis diagrams for the thiocyanate ion, NCS^-, are shown in the table below.

    (a) Assign formal charges to each atom in each Lewis diagram.

	Lewis Diagram	Formal Charge on N	Formal Charge on C	Formal Charge on S
#1				
#2				
#3				

10. (continued)

(b) Which Lewis diagram from part (a), diagram #1, #2, or #3, do you predict to be the most preferred representation of the bonding in the thiocyanate ion? Justify your answer based on formal charges and the electronegativity values shown at right.

Element	Electronegativity
N	3.04
C	2.55
S	2.58

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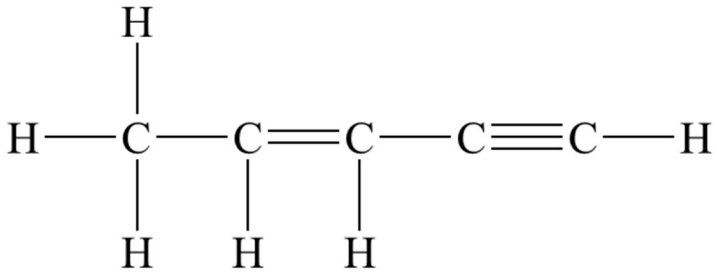
11. Identify the total number of sigma (σ) bonds and pi (π) bonds present in the molecule represented by the Lewis diagram shown below.



_____ sigma (σ) bonds _____ pi (π) bonds

12. Fill in the missing information in the table below.

Substance	Molecular Shape	Polar or Nonpolar?
ClF_3		
SF_4		
XeF_4		
CF_4		
CH_2F_2		

13. For each molecule in the table below,
    - Draw the Lewis diagram. Include both bonding and nonbonding pairs of electrons.
    - Identify the molecular shape.
    - Identify the approximate bond angle.
    - Identify the hybridization (*sp*, sp^2, or sp^3) of the central atom in the molecule.
    - Classify the molecule as polar or nonpolar.

BF_3	NF_3
molecular shape = approximate bond angle = hybridization of central atom = polar or nonpolar?	molecular shape = approximate bond angle = hybridization of central atom = polar or nonpolar?

14. Comparing the Lewis structures of CH_4 and NH_3, each Lewis structure contains a central atom with a total of four electron domains. It is observed from experimental evidence that the bond angle in NH_3 is slightly less than the bond angle in CH_4. Give an explanation for this observation.