

Short Answer

1. For a science fair project, a student wants to design a simple device for removing certain gases from polluted air. He knows that polar molecules dissolve well in water, so he bubbles polluted air through a jug of water to remove unwanted gases. For his project, the student uses air containing the following gases:

- | | |
|-----------------------|-----------------------------------|
| 1. $\text{N}_{2(g)}$ | 5. $\text{CH}_{4(g)}$ |
| 2. $\text{O}_{2(g)}$ | 6. $\text{OCl}_{2(g)}$ |
| 3. $\text{HF}_{(g)}$ | 7. $\text{C}_3\text{H}_{8(g)}$ |
| 4. $\text{NH}_{3(g)}$ | 8. $\text{CH}_3\text{OCH}_{3(g)}$ |

List the gases that will dissolve by writing down their corresponding numbers.

2. List three empirical properties of ionic compounds.
3. Draw Lewis diagrams to explain the empirical formula for the following substances.
- (a) $\text{KI}_{(s)}$
(b) $\text{Br}_{2(l)}$
(c) $\text{O}_{2(g)}$
(d) $\text{BaCl}_{2(s)}$
4. List three empirical properties of the molecular elements (i.e., nonmetals).
5. A student records the following evidence in a lab book.

Unknown substance	Pure state	Solubility in water	Solution conductivity
I	solid	high	low
II	solid	low	low
III	solid	high	none
IV	solid	high	high

Which of the substances in the table above is most likely an ionic compound? Explain your answer.

6. Briefly describe how polar covalent bonds occur.
7. Explain, in your own words, how and why ionic bonding occurs.
8. Use electron dot diagrams to explain the formula for CaCl_2 .
9. Use electron dot diagrams to explain the formula for Na_2O .
10. Draw the electron dot diagrams for ammonia and ammonium ion.
11. Draw the electron dot diagram for carbon monoxide and carbon dioxide.
12. Use an electron dot diagram to explain why Lewis theory predicts that sulfur dioxide has one double bond.
13. Use an electron dot diagram to explain why the cyanide ion contains a triple bond.
14. Use an electron dot diagram to explain why ammonia is a polar molecule.
15. Predict the products, state the type of reaction, and write a balanced chemical equation for the following chemical reactions:
- a) A sulfuric acid spill is neutralized by a sodium hydroxide solution.
- b) Mercury(II) oxide is decomposed by heat to test the law of conservation of mass.
- c) Copper wire is added to an aqueous solution of silver nitrate to recover the silver.
- d) Aqueous calcium chloride is added to a small amount of solution suspected to contain sodium phosphate.
- e) A nitric acid spill is neutralized by a barium hydroxide solution.
- f) Steel wool is burned in a hot flame to produce a fireworks-like effect.
- g) Scrap iron is added to an aqueous solution of copper(II) nitrate to recover the copper.

- h) Aqueous aluminum chloride is added to a solution suspected to contain sodium carbonate.
- i) Pure methane gas is burned in a barbecue.
- k) Potassium metal is added to water.
- l) Hydrochloric acid is neutralized by an aluminum hydroxide suspension.
- m) Charcoal (pure carbon) is burned in a barbecue.
- n) Sodium metal is added to water.
- o) Hydrochloric acid is neutralized by a magnesium hydroxide suspension.

16. What are the products of the reaction between zinc and hydrochloric acid?
17. What are the products of the reaction between butane, $C_4H_{10(g)}$, and oxygen?
18. Complete the following chemical reaction equation, including states of matter and balancing:
 $FeCl_{3(aq)} + Zn_{(s)} \rightarrow$
19. Complete the following chemical reaction equation, including states of matter and balancing:
 $C_2H_5OH_{(l)} + O_{2(g)} \rightarrow$

20. Predict the products for the following chemical reaction and write a balanced chemical equation, complete with SATP states of matter:
 Gallium oxide is decomposed by heat and electricity.

21. What is a chemical bond? Why do atoms form bonds? What is the octet rule? Why are bonded atoms more stable than individual atoms?
22. Define isoelectronic. During the formation of an ionic bond, with which noble gas do each of the following become isoelectronic? a) Be b) Al c) K d) S e) F
23. What is an ionic bond? What are valence electrons and why are they important in ionic bonding? What is the limit on the number of electrons that an atom can lose or gain?
24. Use Lewis structures to show how an ionic bond would form between the following pairs of elements. Write the formula for each compound that is formed.
 - a) Sr and Cl d) Al and S
 - b) Ca and N e) Rb and S
 - c) Mg and I f) K and O
25. What is a molecule? What is a covalent bond? How do covalent bonds differ from ionic bonds? Describe the forces that exist as atoms near each other to form bonds. What is bond length?
26. Use electronegativity values to predict the bond type for each of the following:
 a) N-H b) P-Cl c) Fe-N d) Rb-O e) S-O
 What is a polar bond? What is a dipole? What is a non-polar bond? How can you distinguish between them?
27. Show Lewis and structural diagrams for the following.
 a) NH_3 b) CS_2 c) Cl_2O d) HCN e) CH_3Cl f) PCl_3

Essay

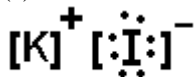
28. Some of the physical properties of water include high boiling point, adhesion to surfaces, cohesion of particles, and attraction of a thin stream to charged objects. Explain these properties using Lewis theory. Draw a diagram.
29. Explain, in your own words, why ionic compounds are brittle, have extremely high melting points, and are solid at SATP.
30. Imagine you live in a poor community that has discovered gold deposits in its land. To recover gold from rock, the ore is ground and mixed with lime. This mixture is then reacted with cyanide. The gold is then absorbed by carbon. A gold mine can do wonders for the local community, but the risk of a cyanide spill has some citizens up in arms. Decide if you think a gold mine and refinery should be constructed and support your position.
31. "Carbon dioxide, water, nitrogen, and oxygen are harmless. If we simply put a catalytic converter in each car, this should solve our car pollution problem."
 Do you agree with this statement? State reasons for your answer and explain what a catalytic converter does.
32. Predict whether or not the following reactions will occur using the reactivity series. Explain your prediction. Predict the products and write a balanced equation for any reaction that occurs.
 - i) $Zn_{(s)} + AgNO_{3(aq)} \Rightarrow$
 - ii) $Pb_{(s)} + FeCl_{2(aq)} \Rightarrow$

SHORT ANSWER

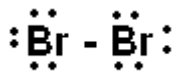
1. ANS:
3, 4, 6, and 8

2. ANS:
Ionic compounds are hard solids at SATP, have high melting and boiling points, and are conductive in liquid and aqueous states.

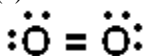
3. ANS:
(a)



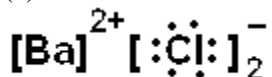
- (b)



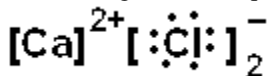
- (c)



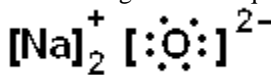
- (d)



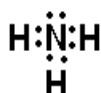
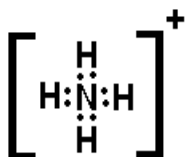
4. ANS:
They may be solids, liquids, or gases at SATP (a great variation in melting and boiling points), are brittle in solid form (not flexible, malleable, ductile, or bendable), and are nonlustrous (not shiny).
5. ANS:
Substance IV is most likely to be an ionic compound because its high solution conductivity indicates that ions are present in the solution.
6. ANS:
When two nonmetals react with each other, they try to form stable octets. To do this, they share electrons. If one atom is much more electronegative than the other, they will not share the electrons equally. Thus, one end of the bond is more negative than the other and the bond is polar.
7. ANS:
Atoms are more stable when they have eight valence electrons. Nonmetals will try to gain electrons to form a stable octet and metals will try to give away electrons to form a stable octet. Thus, metals give electrons to nonmetals. Subsequently, the two oppositely charged ions are attracted to one another.
8. ANS:
Calcium forms an ion with a 2+ charge and chlorine forms an ion with a 1- charge. This means that the smallest unit with a zero charge would require one calcium ion and two chloride ions.



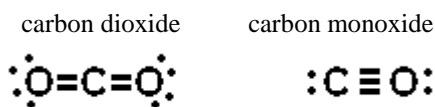
9. ANS:
Sodium forms an ion with a 1+ charge and oxygen forms an ion with a 2- charge. This means that the smallest unit with a zero charge would require two sodium ions and one oxide ion.



10. ANS:
ammonium ion ammonia

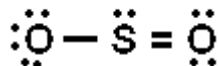


11. ANS:



12. ANS:

Between the one sulfur atom and two oxygen atoms, there are 18 valence electrons. The only way for three atoms to attain stable octets is to arrange themselves as shown in the following diagram.



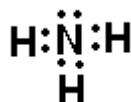
13. ANS:

A carbon atom and a nitrogen atom have nine valence electrons. The negative charge means that there are altogether ten electrons with which the atoms can attain stable octets. The only way to do this is with a triple bond as shown in the following diagram.

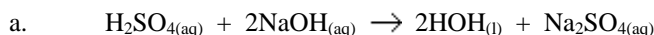


14. ANS:

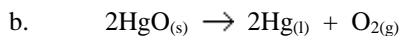
The following diagram shows the electron dot diagram for ammonia. The high electronegativity of nitrogen compared to hydrogen causes the electrons to spend more time with the nitrogen, thus causing a partial negative charge at the nitrogen atom and a partial positive charge at the hydrogen atoms.



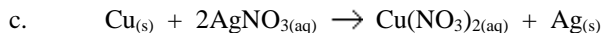
15. ANS:



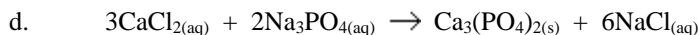
ANS:



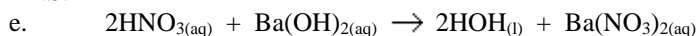
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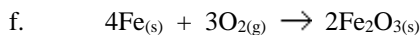
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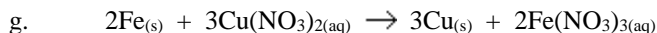
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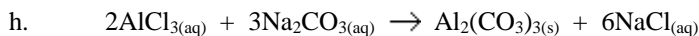
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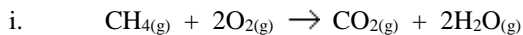
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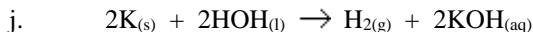
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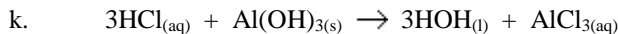
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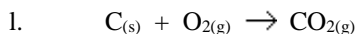
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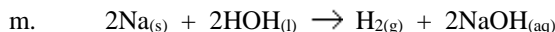
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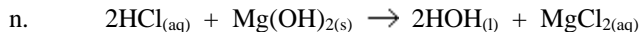
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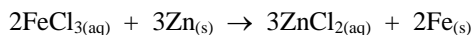
16. ANS:

hydrogen gas and zinc chloride

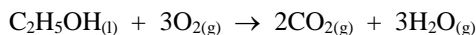
17. ANS:

water and carbon dioxide

18. ANS:



19. ANS:



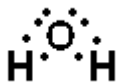
20. ANS:



26. Remember that for non-polar bonds, difference in electronegativity is zero, polar bonds difference in electronegativity is less than 1.7 and greater than 0 and for ionic bonds, difference in electronegativity is greater than 1.7.

ESSAY

28. ANS:



- Water is a polar molecule.
- Hydrogen bonds are formed as a result of the large electronegativity difference between oxygen and hydrogen.
- High boiling point: hydrogen bonds must be overcome to boil water.
- Cohesion: hydrogen bonding holds molecules together.
- Adhesion: polar molecules are attracted to charged surfaces.
- Attraction to charged objects: the molecules are polar.

29. ANS:

- Brittle: if lattice is shifted by an impact, like charges are forced next to each other and repel.
- Relatively strong attraction between ions: the ionic bonds must be overcome to a large degree to break down the crystal lattice and allow the substance to melt.
- Ions arrange themselves so that there is maximum proximity to ions of opposite charge, but maximum distance from ions of same charge. A crystal lattice is formed and ordered particles result in a solid.

30. ANS:

Pros

- Apply modern methods to contain environmental damage.
- Community can force mining company to repair land when the project is complete.
- Community can force mining company to remove contaminants.
- Jobs will be generated.
- There will be more money going into the local economy.

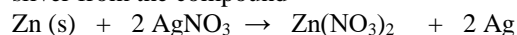
Cons

- Cyanide is extremely toxic.
- Open-pit mines are an eyesore.
- Open-pit mines cause extreme damage to the local environment.
- Community may not have power to enforce environmental rules.

31. ANS:

- Nitrogen monoxide is produced by gasoline engine.
- Platinum/palladium catalyst encourages decomposition of nitrogen monoxide to nitrogen and oxygen.
- Carbon dioxide and water produced by combustion are greenhouse gases. They are not harmless in large amounts.

32. i) A reaction will occur since Zn is higher in the activity series and more reactive, therefore it is able to displace silver from the compound



- ii) There is no reaction since lead is lower in the activity series and not as reactive as iron. Lead will not displace iron from the compound.