

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:

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|-----------------------|-----------------------------------|
| 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.
- $\text{KI}_{(s)}$
 - $\text{Br}_{2(l)}$
 - $\text{O}_{2(g)}$
 - $\text{BaCl}_{2(s)}$
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 sulfuric acid spill is neutralized by a sodium hydroxide solution.
 - Mercury(II) oxide is decomposed by heat to test the law of conservation of mass.
 - Copper wire is added to an aqueous solution of silver nitrate to recover the silver.
 - Aqueous calcium chloride is added to a small amount of solution suspected to contain sodium phosphate.
 - A nitric acid spill is neutralized by a barium hydroxide solution.
 - Steel wool is burned in a hot flame to produce a fireworks-like effect.
 - 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) $Pb_{(s)} + FeCl_{2(aq)} \Rightarrow$