

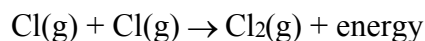
1. What happens when two oxygen atoms combine to form a molecule of oxygen?

- A) Chemical bonds are broken and energy is absorbed.
- B) Chemical bonds are broken and energy is released.
- C) Chemical bonds are formed and energy is absorbed.
- D) Chemical bonds are formed and energy is released.

2. The forces between atoms that create chemical bonds are the result of interactions between

- A) nuclei
- B) electrons
- C) protons and electrons
- D) protons and nuclei

3. Given the reaction:



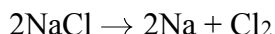
Which statement best describes the reaction?

- A) A bond is formed and energy is absorbed.
- B) A bond is formed and energy is released.
- C) A bond is broken and energy is absorbed.
- D) A bond is broken and energy is released.

4. As a chemical bond forms between two hydrogen atoms the potential energy of the atoms

- A) decreases
- B) increases
- C) remains the same

5. Given the balanced equation representing a reaction:



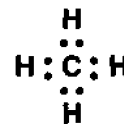
To break the bonds in NaCl, the reactant must

- A) absorb energy
- B) create energy
- C) destroy energy
- D) release energy

6. Which symbol represents an atom in the ground state with the most stable valence electron configuration?

- A) B
- B) O
- C) Li
- D) Ne

7. Given the Lewis electron-dot diagram:



Which electrons are represented by all of the dots?

- A) the carbon valence electrons, only
- B) the hydrogen valence electrons, only
- C) the carbon and hydrogen valence electrons
- D) all of the carbon and hydrogen electrons

8. Which is the correct electron-dot formula for a molecule of chlorine?

- A) $\cdot \text{Cl} : \text{Cl} \cdot$
- B) $\cdot \cdot \quad \cdot \cdot$
 $: \text{Cl} : : \text{Cl} :$
- C) $\cdot \cdot \quad \cdot \cdot$
 $: \text{Cl} : : \text{Cl} :$
- D) $\cdot \cdot \quad \cdot \cdot$
 $: \text{Cl} : \text{Cl} :$

9. Which electron-dot diagram represents H₂?

- A) $\text{H} \cdot \text{H}$
- B) $\text{H} \bullet \text{H}$
- C) $\begin{array}{cc} \cdot & \cdot \\ \cdot & \cdot \\ \text{H} & \cdot \text{H} \\ \cdot & \cdot \end{array}$
- D) $\begin{array}{cc} \cdot & \cdot \\ \cdot & \cdot \\ \text{H} & \bullet \text{H} \\ \cdot & \cdot \end{array}$

10. Which term indicates how strongly an atom attracts the electrons in a chemical bond?

- A) alkalinity
- B) atomic mass
- C) electronegativity
- D) activation energy

11. Which of the following elements is most likely to form a compound with radon?

- A) iodine
- B) fluorine
- C) sodium
- D) calcium

12. Which atom has the *least* attraction for the electrons in a bond between that atom and an atom of hydrogen?

- A) carbon
- B) nitrogen
- C) oxygen
- D) fluorine

13. In which compound do the atoms have the greatest difference in electronegativity?

- A) NaBr
- B) AlCl₃
- C) KF
- D) LiI

14. Which compound would most likely have the greatest ionic character?

- A) CO
- B) KF
- C) CaO
- D) LiH

15. Base your answer to the following question on Given the electron dot formula:



Which atom represented as X would have the *least* attraction for the electrons that form the bond?

- A) F B) Cl C) I D) Br
16. Which compound contains both ionic and covalent bonds?
- A) CaCO_3 B) PCl_3
C) MgF_2 D) CH_2O
17. Which compound contains ionic bonds?
- A) N_2O B) Na_2O C) CO D) CO_2
18. When metals combine with nonmetals, the metallic atoms tend to
- A) lose electrons and become positive ions
B) lose electrons and become negative ions
C) gain electrons and become positive ions
D) gain electrons and become negative ions
19. Which compound contains *only* ionic bonds?
- A) HNO_3 B) NH_4Cl
C) H_2O D) Na_2O
20. The transfer of electrons from sodium atoms to chlorine atoms results in the formation of
- A) coordinate covalent bonds
B) polar covalent bonds
C) nonpolar bonds
D) ionic bonds
21. Base your answer to the following question on The data table below represents the properties determined by the analysis of substances A, B, C, and D.

Substance	Melting Point ($^{\circ}\text{C}$)	Boiling Point ($^{\circ}\text{C}$)	Conductivity
A	-80	-20	none
B	20	190	none
C	320	770	as solid
D	800	1250	in solution

Which substance is an ionic compound?

- A) A B) B C) C D) D

22. Which of the following solids has the highest melting point?

- A) $\text{H}_2\text{O}(\text{s})$ B) $\text{Na}_2\text{O}(\text{s})$
C) $\text{SO}_2(\text{s})$ D) $\text{CO}_2(\text{s})$

23. Which type of bonding is characteristic of a substance that has a high melting point and electrical conductivity only in the liquid phase?

- A) nonpolar covalent B) coordinate covalent
C) ionic D) metallic

24. Which of the following substances is the best conductor of electricity?

- A) $\text{H}_2\text{O}(\text{g})$ B) $\text{H}_2\text{O}(\text{s})$
C) $\text{NaCl}(\text{s})$ D) $\text{NaCl}(\ell)$

25. A molecular compound is formed when a chemical reaction occurs between atoms of

- A) chlorine and sodium
B) chlorine and yttrium
C) oxygen and hydrogen
D) oxygen and magnesium

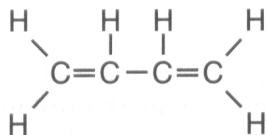
26. What is the total number of electron pairs shared between the two atoms in an O_2 molecule?

- A) 1 B) 2 C) 6 D) 4

27. The nitrogen atoms in a molecule of N_2 share a total of

- A) one pair of electrons
B) one pair of protons
C) three pairs of electrons
D) three pairs of protons

28. Base your answer to the following question on Given the formula of a substance:



What is the total number of shared electrons in a molecule of this substance?

- A) 22 B) 11 C) 9 D) 6

29. Which atoms are most likely to form covalent bonds?

- A) metal atoms that share electrons
B) metal atoms that share protons
C) nonmetal atoms that share electrons
D) nonmetal atoms that share protons

30. Which formula represents a molecular solid?

- A) $\text{NaCl}(\text{s})$ B) $\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$
C) $\text{Cu}(\text{s})$ D) $\text{KF}(\text{s})$

31. Which element forms a diatomic molecule containing a triple covalent bond?

- A) H_2 B) Cl_2 C) N_2 D) O_3

32. Base your answer to the following question on A chemist performs the same tests on two homogeneous white crystalline solids, *A* and *B*. The results are shown in the table below.

	Solid A	Solid B
Melting Point	High, 801°C	Low, decomposes at 186°C
Solubility in H ₂ O (grams per 100.0 g H ₂ O at 0°C)	35.7	3.2
Electrical Conductivity (in aqueous solution)	Good conductor	Nonconductor

The results of these tests suggest that

- A) both solids contain only ionic bonds
 B) both solids contain only covalent bonds
 C) solid *A* contains only covalent bonds and solid *B* contains only ionic bonds
 D) solid *A* contains only ionic bonds and solid *B* contains only covalent bonds

33. What is the maximum number of covalent bonds that a carbon atom can form?

A) 1 B) 2 C) 3 D) 4

34. Which type of bond is found between atoms of solid cobalt?

A) nonpolar covalent B) polar covalent
 C) metallic D) ionic

35. A solid substance is an excellent conductor of electricity. The chemical bonds in this substance are most likely

A) ionic, because the valence electrons are shared between atoms
 B) ionic, because the valence electrons are mobile
 C) metallic, because the valence electrons are stationary
 D) metallic, because the valence electrons are mobile

36. Which substance contains metallic bonds?

A) Hg(*ℓ*) B) H₂O(*ℓ*)
 C) NaCl(s) D) C₆H₁₂O₆(s)

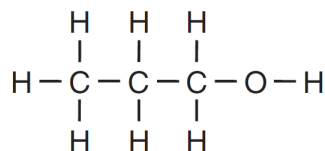
37. Which element consists of positive ions immersed in a "sea" of mobile electrons?

A) sulfur B) nitrogen
 C) calcium D) chlorine

38. Which substance contains particles held together by metallic bonds?

A) Ni(s) B) Ne(s) C) N₂(s) D) I₂(s)

39. Given the formula:



The bond between which two atoms has the greatest degree of polarity?

A) C and C B) C and O
 C) H and C D) H and O

40. Which molecule has a nonpolar covalent bond?

A) H-H B) $\begin{array}{c} \text{H} \\ \diagdown \text{N} \diagup \\ \text{H} \end{array}$
 C) $\text{H} \text{---} \text{O} \text{---} \text{H}$ D) H-Cl

41. Which formula represents a molecule having a nonpolar covalent bond?

A) $\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{N}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$ B) $\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{H} \\ | \\ \text{H} \end{array}$
 C) $\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$ D) $\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{H} \end{array}$

42. The degree of polarity of a chemical bond in a molecule of a compound can be predicted by determining the difference in the
- melting points of the elements in the compound
 - densities of the elements in the compound
 - electronegativities of the bonded atoms in a molecule of the compound
 - atomic masses of the bonded atoms in a molecule of the compound
43. Which formula represents a nonpolar molecule containing polar covalent bonds?
- H₂O
 - CCl₄
 - NH₃
 - H₂
44. Which formula represents a nonpolar molecule?
- CH₄
 - HCl
 - H₂O
 - NH₃
45. Which type of bond exists between an atom of carbon and an atom of fluorine?
- ionic
 - metallic
 - polar covalent
 - nonpolar covalent
46. Which electron-dot diagram represents a molecule that has a polar covalent bond?
- - $\text{Li}^+ [\text{Cl}]^-$ (with one pair of electrons between Li and Cl)
 -
 - $\text{K}^+ [\text{Cl}]^-$ (with one pair of electrons between K and Cl)
47. The electrons in a bond between two iodine atoms (I₂) are shared
- equally, and the resulting bond is polar
 - equally, and the resulting bond is nonpolar
 - unequally, and the resulting bond is polar
 - unequally, and the resulting bond is nonpolar
48. Which phrase describes the distribution of charge and the polarity of a CH₄ molecule?
- symmetrical and polar
 - symmetrical and nonpolar
 - asymmetrical and polar
 - asymmetrical and nonpolar
49. Which formula represents a polar molecule?
- H₂
 - H₂O
 - CO₂
 - CCl₄
50. Which formula represents a nonpolar molecule?
- HCl
 - H₂O
 - NH₃
 - CH₄
51. Which formulas represent two polar molecules?
- CO₂ and HCl
 - CO₂ and CH₄
 - H₂O and HCl
 - H₂O and CH₄
- Base your answers to questions 52 and 53 on your knowledge of chemical bonding and on the Lewis electron-dot diagrams of H₂S, CO₂, and F₂ below.
-
52. Which atom, when bonded as shown, has the same electron configuration as an atom of argon?
53. Explain, in terms of structure and/or distribution of charge, why CO₂ is a nonpolar molecule.
-
54. Which molecule is nonpolar?
- H₂O
 - NH₃
 - CO
 - CO₂
55. Which pair of characteristics describes the molecule illustrated below?
-
- symmetrical and polar
 - symmetrical and nonpolar
 - asymmetrical and polar
 - asymmetrical and nonpolar
56. The four single bonds of a carbon atom in CH₄ are directed toward the corners of a
- square
 - tetrahedron
 - rectangle
 - parallelogram
57. Which molecule has an asymmetrical shape?
- N₂
 - NH₃
 - Cl₂
 - CCl₄
58. The diagram below represents a water molecule.
-
- This molecule is best described as
- polar with polar covalent bonds
 - polar with nonpolar covalent bonds
 - nonpolar with polar covalent bonds
 - nonpolar with nonpolar covalent bonds

59. Which molecule is polar?

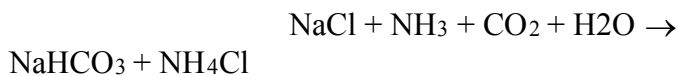
- A) H₂ B) N₂ C) CH₄ D) HCl

60. Which structural formula represents a linear nonpolar molecule containing two polar bonds?

- A) $\text{N} \equiv \text{N}$ B) $\text{H}-\text{C} \equiv \text{C}-\text{H}$
- C) $\begin{array}{c} \text{O} \\ / \quad \backslash \\ \text{H} \quad \text{H} \end{array}$ D) $\begin{array}{c} \text{H} \quad \quad \text{H} \\ \backslash \quad / \\ \text{C} = \text{C} \\ / \quad \backslash \\ \text{H} \quad \quad \text{H} \end{array}$

Base your answers to questions 61 and 62 on the information below.

In 1864, the Solvay process was developed to make soda ash. One step in the process is represented by the balanced equation below.



61. In the space draw a Lewis electron-dot diagram for the reactant containing nitrogen in the equation.

62. Explain, in terms of electronegativity difference, why the bond between hydrogen and oxygen in a water molecule is more polar than the bond between hydrogen and nitrogen in an ammonia molecule.

63. Base your answer to the following question on the information below.

**Physical Properties of CF₄ and NH₃
at Standard Pressure**

Compound	Melting Point (°C)	Boiling Point (°C)	Solubility in Water at 20.0°C
CF ₄	-183.6	-127.8	insoluble
NH ₃	-77.7	-33.3	soluble

In the space *in your answer booklet*, draw a Lewis electron-dot diagram for CF₄.

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64. Bromine is the only liquid nonmetallic element at room temperature. It is a heavy, mobile, reddish-brown liquid, volatilizing readily at room temperature to a red vapor with a strong disagreeable odor, resembling chlorine, and having a very irritating effect on the eyes and throat; it is readily soluble in water or carbon disulfide, forming a red solution, is less active than chlorine but more so than iodine; it unites readily with many elements and has a bleaching action; when spilled on the skin it produces painful sores. It presents a serious health hazard, and maximum safety precautions should be taken when handling it.

a Draw the electron-dot diagram of a molecule of bromine, Br₂.

b Why does bromine have properties resembling chlorine?

65. *a*) Draw the structural formula for H₂O.

b) Is this molecule polar or nonpolar? Explain your answer.

66. Draw an electron-dot diagram for *each* of the following substances:

a calcium oxide (an ionic compound)

b hydrogen bromide

c carbon dioxide
