1. Identify the net ionic equation for the reaction of HCl and Ba(OH)₂.

\[ 2\text{HCl}(aq) + \text{Ba(OH)}_2(aq) \rightarrow \text{BaCl}_2(aq) + 2\text{H}_2\text{O}(l) \]

(a) HCl(aq) + OH⁻(aq) → Cl⁻(aq) + H₂O(l)
(b) 2HCl(aq) + Ba(OH)₂(aq) → 2Cl⁻(aq) + Ba²⁺(aq) + 2H₂O(l)
(c) H⁺(aq) + OH⁻(aq) → H₂O(l)
(d) 2H⁺(aq) + 2OH⁻(aq) → 2H₂O(l)
(e) 2HCl(aq) + Ba²⁺(aq) → BaCl₂(aq) + 2H⁺(aq)

2. The molarity of a solution is defined as
   I. the number of moles of solute per kilogram of solvent.
   II. the number of moles of solute per liter of solution.
   III. the number of equivalent weights of solute per liter of solution.
   IV. the number of moles of solute per kilogram of solution.
   V. the number of moles of solute per liter of solvent.

(a) I  (b) I and II  (c) II and III  (d) II  (e) I, II, and III

3. In the following reaction, the oxidizing agent is ____, when it is __________ in the following reaction.

\[ 6\text{KOH}(aq) + 3\text{Cl}_2(aq) \rightarrow \text{KClO}_3(aq) + 5\text{KCl}(aq) + 3\text{H}_2\text{O}(l) \]

(a) Cl₂, reduced to KCl  (b) Cl₂, oxidized to KClO₃
(c) Cl₂, oxidized to KCl  (d) Cl₂, reduced to KClO₃
(e) KOH, reduced to H₂O

4. Suppose you have a 100-gram sample of each of the following compounds. Which sample contains the smallest number of moles of hydrogen atoms?

(a) NH₃  (b) H₂O  (c) H₃PO₄  (d) CH₄  (e) HClO

5. These three species \(^{80}\text{Se}, {81}\text{Br}\) and \(^{82}\text{Kr}\) have

(a) the same atomic mass.  (b) the same number of protons.
(c) the same number of neutrons.  (d) the same mass number.
(e) the same number of electrons.

6. The total number of electrons in \(p\) orbitals in a palladium atom (atomic number = 46) in its ground state is: __________.

(a) 6  (b) 12  (c) 18  (d) 24  (e) 30
7. Which of the following atoms or ions is **not** diamagnetic?
   (a) S\(^{2-}\)    (b) Zn    (c) Mg    (d) Mg\(^{2+}\)    (e) B

8. What is the electronic geometry for 5 regions of high electron density on a central atom?
   (a) octahedral    (b) square planar    (c) tetrahedral
   (d) trigonal bipyramidal    (e) trigonal planar

9. Which of the following changes in water represents a **chemical** change?
   (a) Melting of ice.
   (b) Boiling water.
   (c) Sublimation of solid ice directly to gaseous water.
   (d) Calcium reacting with water to produce calcium hydroxide.
   (e) Heating water from 25ºC to 60ºC.

10. Which response includes all the compounds listed below and only the compounds?
    I. ethyl alcohol    II. air
    III. mercury    IV. steam
    V. calcium fluoride
    (a) I, II, and IV    (b) III and V
    (c) II, IV, and V    (d) I, III, and IV
    (e) another one or another combination

11. If 25 grams of methane, CH\(_4\), and 30 g of ammonia, NH\(_3\), are combined with excess oxygen, how much **methane or ammonia** will be left when the reaction is finished?

\[
2\text{CH}_4 + 2\text{NH}_3 + 3\text{O}_2 \rightarrow 2\text{HCN} + 6\text{H}_2\text{O}
\]

   (a) 0.10g NH\(_3\)    (b) 0.20 mol CH\(_4\)
   (c) 0.10 g CH\(_4\)    (d) 10 g NH\(_3\)
   (e) 0.20 mol NH\(_3\)

12. What is the percent by mass of sulfur in Al\(_2\)(SO\(_4\))\(_3\)?

   (a) 9.38%    (b) 18.8%    (c) 24.6%
   (d) 28.1%    (e) 35.4%
13. Which of the following statements about AsF$_5$ is false?
   a. The electronic geometry is trigonal bipyramidal.
   b. As is $sp^3d$ hybridized.
   c. As has one lone pair.
   d. Bonding angles are 90°, 120° or 180°.
   e. The molecular geometry is trigonal bipyramidal.

14. What volume of 40.0% NaNO$_3$ solution contains 0.15 mole of NaNO$_3$?
   Density = 1.32 g/mL.
   (a) 42.0 mL  (b) 3.86 mL  (c) 9.60 mL
   (d) 24.1 mL  (e) 38.2 mL

15. Calculate the molarity of the resulting solution if enough water is added to 50.0 mL of 4.20 M NaCl solution to make a solution with a volume of 2.80 L.
   (a) 75.0 M  (b) 0.043 M  (c) 33.1 M
   (d) 0.067 M  (e) 0.0750 M

16. What volume of 0.130 M HCl solution will just react with 0.424 gram of Ba(OH)$_2$?

   \[ 2\text{HCl} + \text{Ba(OH)}_2 \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O} \]

   (a) 38.1 mL  (b) 32.6 mL  (c) 24.1 mL
   (d) 18.6 mL  (e) 96.7 mL

17. Arrange the following elements in order of *increasing* first ionization energy.
   Mg, Al, Si, P, S
   (a) Al < Mg < Si < S < P  (b) Mg < Al < Si < P < S
   (c) Al < Mg < Si < P < S  (d) Mg < Al < Si < S < P
   (e) Al < Mg < P < Si < S

18. Which of the following elements has the most negative electron affinity?
   (a) Si  (b) P  (c) S  (d) Se  (e) Te

19. Which of the following anions represents a peroxide?
   (a) O$^-$  (b) O$_2^-$  (c) O$^{2-}$  (d) O$_2^{2-}$  (e) O$_3^-$
20. Which of the following oxides does not give an acidic solution when dissolved in water?
(a) SO₂  (b) CO₂  (c) N₂O₅  (d) P₄O₁₀  (e) Na₂O

21. Arrange the following in order of increasing acidic character (most acidic at the right).
   Al₂O₃, Na₂O, N₂O₅
   (a) Al₂O₃ < Na₂O < N₂O₅  (b) N₂O₅ < Al₂O₃ < Na₂O  
   (c) Al₂O₃ < N₂O₅ < Na₂O  (d) Na₂O < Al₂O₃ < N₂O₅  
   (e) Na₂O < N₂O₅ < Al₂O₃

22. The number of unshared pairs of electrons in the outer shell of oxygen in Cl₂O is _________.
   (a) one  (b) two  (c) three  (d) four  (e) zero

23. The Lewis dot formula for CO₂ shows
   (a) two single covalent bonds.
   (b) one single covalent bond and one double covalent bond.
   (c) one single covalent bond and one triple covalent bond.
   (d) a total of 8 x 3 = 24 electrons (dots).
   (e) two double covalent bonds.

24. How many resonance structures does the nitrate ion, NO₃⁻, have?
   (a) one  (b) two  (c) three  (d) four  (e) zero

25. Which of the following molecules has the most ionic bond character?
   (a) NCl₃  (b) F₂  (c) HF  (d) ClF  (e) HCl

26. According to the Arrhenius theory, which of the following is a base?
   (a) CsOH  (b) HOOH  (c) CH₃OH  (d) HCOOH  (e) CH₃COOH

27. What is the molarity of H₃PO₄ if 86 mL of 0.35 N solution is diluted to 5.00 L?
   (a) 0.00602 M  (b) 0.0181 M  (c) 0.00301 M
   (d) 0.00201 M  (e) 6.78 M

28. What is the oxidation number of tin in the HSnO₃⁻ ion?
   (a) +1  (b) +2  (c) +3  (d) +4  (e) +5
29. When balancing the following net ionic equation by the half reaction method, what is the sum of the coefficients, including the coefficient of the electrons, in the oxidation half-reaction?
\[ \text{Pb}^{4+} + \text{SeO}_3^{2-} \rightarrow \text{Pb}^{2+} + \text{SeO}_4^{2-} \] (aqueous, acidic solution)
(a) eight (b) ten (c) twelve (d) four (e) seven

30. What is the pressure of 64.0 g of oxygen gas in a 1.50-L container at -37°C?
(a) 4.12 atm (b) 25.8 atm (c) 51.6 atm (d) 19.6 atm (e) 8.2 atm

31. A 300.-mL sample of hydrogen, H₂, was collected over water at 21°C on a day when the barometric pressure was 748 torr. What mass of hydrogen is present? The vapor pressure of water is 19 torr at 21°C.
(a) 0.0186 g (b) 0.0240 g (c) 0.0213 g (d) 0.0269 g (e) 0.0281 g

32. If an element consisted of three isotopes in the following relative abundance, what would the atomic weight of the element be? This is a hypothetical example.

- 30.00% 37.00 amu
- 50.00% 38.00 amu
- 20.00% 40.00 amu

(a) 38.00 amu (b) 38.10 amu (c) 38.20 amu (d) 39.98 amu (e) none of these

33. For which of the following would hydrogen bonding not be an important factor in determining physical properties in the liquid state?
(a) HI (b) H₂O (c) HF (d) NH₃ (e) H₂O₂

34. How much heat is released when 40.0 g of steam at 250.0°C cools and condenses to water at 30.0°C? (Sp. heat of H₂O(l) = 4.18 J/g°C, Sp. heat of H₂O(g) = 2.03 J/g°C, heat of vap. of H₂O(l) = 2.260 kJ/g)
(a) 24.0 kJ (b) 23.0 J (c) 32.9 kJ (d) 114 kJ (e) 122 kJ

35. Which one of the following pairs is incorrectly matched?

<table>
<thead>
<tr>
<th>Substance</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>sand</td>
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<tr>
<td>diamond</td>
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<td>Fe</td>
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<td>CaF₂</td>
<td>ionic solid</td>
</tr>
<tr>
<td>quartz</td>
<td>covalent solid</td>
</tr>
</tbody>
</table>

36. If the mole fraction of methyl alcohol in a solution (with only water) is 0.28, what is the mole fraction of the water in that solution?
(a) 0.28 (b) 1.28 (c) 0.62 (d) 0.72 (e) 0.36
37. Calculate the freezing point of a solution that contains 68.4 g of sucrose (table sugar) in 300. g of water. One mole of sucrose is 342 g. \( K_f \) for \( H_2O \) = 1.86ºC/\( m \).
(a) - 0.186ºC  (b) - 0.372ºC  (c) - 0.558ºC  (d) - 0.744ºC  (e) -1.24ºC

38. When 1.150 grams of an unknown nonelectrolyte dissolves in 10.0 grams of water, the solution freezes at -2.16ºC. What is the molecular weight of the unknown compound? \( K_f \) for water = 1.86ºC/\( m \).
(a) 88.6 g/mol  (b) 116 g/mol  (c) 74.2 g/mol  (d) 99.0 g/mol  (e) 132 g/mol

39. Estimate the molecular weight of a biological macromolecule if a 0.100-gram sample dissolved in 50.0 mL of benzene has an osmotic pressure of 9.76 torr at 25.0ºC.
(a) 3.8 x 10^3 g/mol  (b) 4.2 x 10^4 g/mol  (c) 5.6 x 10^4 g/mol
(d) 6.7 x 10^4 g/mol  (e) 8.3 x 10^3 g/mol

40. What is the van’t Hoff factor for a dilute solution of CaCl\(_2\) likely to be?
(a) exactly 3  (b) exactly 2  (c) exactly 1  (d) slightly less than 3  (e) slightly less than 2

ANSWERS: 1 (c), 2 (d), 3 (a), 4 (e), 5 (c), 6 (c), 7 (e), 8 (d), 9 (d), 10 (e), 11 (e), 12 (d), 13 (c), 14 (d), 15 (e), 16 (a), 17 (a), 18 (c), 19 (d), 20 (e), 21 (d), 22 (b), 23 (e), 24 (c), 25 (c), 26 (a), 27 (d), 28 (d), 29 (e), 30 (b), 31 (b), 32 (b), 33 (a), 34 (d), 35 (b), 36 (d), 37 (e), 38 (d), 39 (a), 40 (d)