Lithium and nitrogen react in a combination reaction to produce lithium nitride:

\[ 6\text{Li (s)} + \text{N}_2 \text{(g)} \rightarrow 2\text{Li}_3\text{N (s)} \]

In a particular experiment, 3.50-g samples of each reagent are reacted. The theoretical yield of lithium nitride is __________ g.

(A) 3.52  
(B) 2.93  
(C) 17.6  
(D) 5.85  
(E) 8.7

Which one of the following is an endothermic process?

(A) ice melting  
(B) water freezing  
(C) boiling soup  
(D) Hydrochloric acid and barium hydroxide are mixed at 25 °C: the temperature increases.  
(E) Both A and C

The central atom in __________ violates the octet rule.

(A) \( \text{NH}_3 \)  
(B) \( \text{SeF}_5 \)  
(C) \( \text{BF}_3 \)  
(D) \( \text{AsF}_5 \)  
(E) \( \text{CF}_4 \)

The angles between \( \text{sp}^2 \) orbitals are __________.

(A) 45 °  
(B) 180 °  
(C) 90 °  
(D) 109.5 °  
(E) 120 °
(5) Of the following, ________ has the highest boiling point.
(A) N₂
(B) Br₂
(C) H₂
(D) Cl₂
(E) O₂

(6) Which of the following substances is more likely to dissolve in CH₃OH?
(A) CCl₄
(B) Kr
(C) N₂
(D) CH₃CH₂OH
(E) H₂

(7) An aqueous solution of ________ will produce a basic solution.
(A) NH₄ClO₄
(B) KBr
(C) NaCl
(D) NaHSO₄
(E) Na₂SO₃

(8) Which compound listed below has the greatest molar solubility in water?
(A) CdCO₃
(B) Cd(OH)₂
(C) AgI
(D) CaF₂
(E) ZnCO₃

(9) Which of the following reactions is a redox reaction?
(a) K₂Cr₂O₇ + BaCl₂ → BaCrO₄ + 2KCl
(b) Pb₂⁺ + 2Br⁻ → PbBr₂
(c) Cu + S → CuS
(A) (a) only
(B) (b) only
(C) (c) only
(D) (a) and (c)
(E) (b) and (c)
(10) The interhalogen compound $\text{ICl}_3$ can form but $\text{BrCl}_3$ cannot form. This is because
(A) iodine is large enough to accommodate three chlorine atoms around itself.
(B) bromine is not electronegative enough to react with chlorine.
(C) bromine is too electronegative to react with chlorine.
(D) iodine can have a positive oxidation state but bromine cannot.
(E) iodine can have a negative oxidation state but bromine cannot.

(11) Which of the following compounds do not contain an $sp^3$ hybridized oxygen atom?
(A) ketones
(B) alcohols
(C) ethers
(D) esters
(E) water

(12) In a solution, when the concentrations of a weak acid and its conjugate base are equal,
(A) the system is not at equilibrium.
(B) the buffering capacity is significantly decreased.
(C) the $-\log$ of the $[H^+]$ and the $-\log$ of the $K_a$ are equal.
(D) all of the above are true.

(13) What orbital has the quantum numbers $n=3, l=2, m_l=-1$?
(A) $s$  (B) $p$  (C) $d$  (D) $f$  (E) $g$

(14) The intramolecular bonding in water is best characterized as
(A) hydrogen bonding  (B) ionic  (C) coordinate covalent
(D) polar covalent  (E) nonpolar covalent

(15) Which of the following molecules is polar?
(A) $\text{BF}_3$  (B) $\text{CCl}_4$  (C) $\text{CO}_2$  (D) $\text{NO}_2$  (E) $\text{SF}_6$

(16) The $\text{pH}$ of $0.1 \text{ M NH}_3$ is approximately
(A) 1  (B) 3  (C) 7  (D) 11  (E) 13

(17) One molar solutions of the following three salts: $\text{NaCl}$, $\text{CaCl}_3$, $\text{FeCl}_3$. Will result in
solutions that are, respectively,
(A) neutral, neutral, and acidic.  (B) neutral, basic, and acidic.
(C) basic, basic, and acidic.  (D) acidic, acidic, and acidic.
(E) neutral, basic, and basic.

(18) For a certain oxidation-reduction reaction, $E^\circ$ is positive. This means that
(A) $\Delta G^\circ$ is negative and $K$ is less than 1.
(B) $\Delta G^\circ$ is negative and $K$ is greater than 1.
(C) $\Delta G^\circ$ is zero and $K$ is greater than 1.
(D) $\Delta G^\circ$ is positive and $K$ is greater than 1.
(E) $\Delta G^\circ$ is positive and $K$ is less than 1.

(19) Which oxide is the most acidic?
(A) $\text{N}_2\text{O}_5$  (B) $\text{N}_2\text{O}_3$  (C) $\text{Cl}_2\text{O}_7$  (D) $\text{Cl}_2\text{O}_3$  (E) $\text{NO}$
Two platinum complexes of the formula Pt(NH₃)₂Cl₂ have been studied. The hybrid orbitals occupied by the bonding electrons are
(A) sp²  (B) sp³  (C) dsp²  (D) dsp³  (E) d²sp³.

In which compound is cobalt in the highest oxidation state?
(A) K₄[CoF₆]  (B) Co₂(CO)₈  (C) [Co(NH₃)₆]Cl₂
(D) Na₂[CoCl₄]  (E) [Co(NH₃)₄Cl₂]

Which of the following coordination compounds will immediately form a precipitate when combined with an AgNO₃ solution?
(A) Cr(NH₃)₃Cl₃  (B) K[Cr(NH₃)₂Cl₄]  (C) Cr(NH₃)₂(H₂O)(Cl₃)
(D) K₃[Cr(CN)₆]  (E) [Cr(NH₃)₆]Cl₃

The most characteristic reaction of benzene is
(A) oxidation  (B) reduction  (C) substitution
(D) addition  (E) addition and elimination.

The functional group of an alkyne consists of
(A) 1σ bond and 2π bonds  (B) 1σ bond and 1π bond
(C) 2σ bond and 1π bond  (D) 3σ bonds  (E) 3π bonds.

Fatty acid are linked to glycerol by
(A) an acid linkage  (B) a peptide linkage  (C) an aldehyde linkage
(D) an ester linkage  (E) an alcohol linkage.

二、問答題（每題 5 分，共 25 分）

（1）分子質譜法中的離子源有哪些？

（2）某化合物其分子式為C₅H₁₀O₂，IR光譜在3450 cm⁻¹(broad)及1713 cm⁻¹(strong)有吸收訊號，其NMR光譜如下。試解出此化合物構造。

（3）請簡單論述熱力學第二定律。

（4）Seawater has a pOH of 5.90. What is its hydroxide-ion concentration?

（5）K_a for CH₃CH₂COOH is 1.34 x 10⁻⁵. What is K_b for CH₃CH₂COO⁻ ?