一、選擇題（每題 4 分，共 80 分）

1. The correct name for $\text{HClO}_3$ is __________.
   (A) hydrochloric acid
   (B) perchloric acid
   (C) chloric acid
   (D) chlorous acid
   (E) hydrochlorous acid

2. The spectator ions in the reaction between aqueous hydrofluoric acid and aqueous barium hydroxide are __________.
   (A) $\text{OH}^-, \text{F}^-, \text{and Ba}^{2+}$
   (B) $\text{F}^-, \text{and Ba}^{2+}$
   (C) $\text{OH}^- \text{ and F}^-$
   (D) $\text{Ba}^{2+}$ only
   (E) $\text{H}^+, \text{OH}^-, \text{F}^-, \text{and Ba}^{2+}$

3. An electron in a Bohr hydrogen atom has an energy of $-1.362 \times 10^{-19} \text{ J}$ The value of $n$ for this electron is __________.
   (A) 1
   (B) 2
   (C) 3
   (D) 4
   (E) 5
4. Consider the general valence electron configuration of $ns^2np^5$ and the following statements:

(i) Elements with this electron configuration are expected to form -1 anions.

(ii) Elements with this electron configuration are expected to have large positive electron affinities.

(iii) Elements with this electron configuration are nonmetals.

(iv) Elements with this electron configuration form acidic oxides.

Which statements are true?

(A) (i) and (ii)
(B) (i), (ii), and (iii)
(C) (ii) and (iii)
(D) (i), (iii,) and (iv)
(E) All statements are true.

5. The hybridizations of nitrogen in $NF_3$ and $NH_3$ are __________ and __________, respectively.

(A) $sp^2$, $sp^3$
(B) $sp$, $sp^3$
(C) $sp^3$, $sp$
(D) $sp^3$, $sp^3$
(E) $sp^2$, $sp^3$

6. Which of the following statements about gases is false?

(A) Gases are highly compressible.

(B) Distances between molecules of gas are very large compared to bond distances within molecules.

(C) Non-reacting gas mixtures are homogeneous.

(D) Gases expand spontaneously to fill the container they are placed in.

(E) All gases are colorless and odorless at room temperature.
A sample of potassium nitrate (49.0 g) is dissolved in 101 g of water at 100 °C, with precautions taken to avoid evaporation of any water. The solution is cooled to 30.0 °C and no precipitate is observed. This solution is ______________.

(A) hydrated
(B) placated
(C) saturated
(D) unsaturated
(E) supersaturated

8. For a first-order reaction, a plot of __________ versus __________ is linear.

(A) \( \ln[A] - \frac{1}{t} \)

(B) \( \ln[A], t \)

(C) \( \frac{1}{[A]}, t \)

(D) \( [A], t \)

(E) \( \frac{1}{[A]}, t \)
9. Which one of the following statements regarding $K_w$ is false?
(A) $pK_w$ is 14.00 at 25 °C
(B) The value of $K_w$ is always $1.0 \times 10^{-14}$.
(C) $K_w$ changes with temperature.
(D) The value of $K_w$ shows that water is a weak acid.
(E) $K_w$ is known as the ion product of water.

10. Of the substances below, __________ will decrease the solubility of Pb(OH)$_2$ in a saturated solution.
(A) NaNO$_3$
(B) H$_2$O$_2$
(C) HNO$_3$
(D) Pb(NO$_3$)$_2$
(E) NaCl

11. The first law of thermodynamics can be given as __________.
(A) $\Delta E = q + w$
(B) $\Delta H^\circ_{rxn} = \sum n\Delta H^\circ_f (products) - \sum m\Delta H^\circ_f (reactants)$
(C) for any spontaneous process, the entropy of the universe increases
(D) the entropy of a pure crystalline substance at absolute zero is zero
(E) $\Delta S = q_{rev}/T$ at constant temperature

12. The half-reaction occurring at the anode in the balanced reaction shown below is __________.
$3\text{MnO}_4^- (aq) + 24\text{H}^+ (aq) + 5\text{Fe} (s) \to 3\text{Mn}^{2+} (aq) + 5\text{Fe}^{3+} (aq) + 12\text{H}_2\text{O}(l)$
(A) $\text{MnO}_4^- (aq) + 8\text{H}^+ (aq) + 5\text{e}^- \to \text{Mn}^{2+} (aq) + 4\text{H}_2\text{O}(l)$
(B) $2\text{MnO}_4^- (aq) + 12\text{H}^+ (aq) + 6\text{e}^- \to 2\text{Mn}^{2+} (aq) + 3\text{H}_2\text{O}(l)$
(C) $\text{Fe}(s) \to \text{Fe}^{3+} (aq) + 3\text{e}^-$
(D) $\text{Fe}(s) \to \text{Fe}^{2+} (aq) + 2\text{e}^-$
(E) $\text{Fe}^{2+} (s) \to \text{Fe}^{3+} (aq) + \text{e}^-$
13. To produce carbon black, __________.
   (A) diamond is exposed to extremely high pressures and temperatures
   (B) wood is strongly heated in the absence of oxygen
   (C) coal is strongly heated in the absence of oxygen
   (D) hydrocarbons such as methane are heated in a very limited supply of oxygen
   (E) graphite is cooled to −273 °C

14. A reaction that is spontaneous as written __________.
   (A) is very rapid
   (B) will proceed without outside intervention
   (C) is also spontaneous in the reverse direction
   (D) has an equilibrium position that lies far to the left
   (E) is very slow

15. The molar concentration of hydronium ion in pure water at 25 °C is __________.
   (A) 0.00
   (B) $1.0 \times 10^{-7}$
   (C) $1.0 \times 10^{-14}$
   (D) 1.00
   (E) 7.00

16. The rate of a reaction depends on __________.
   (A) collision frequency
   (B) collision energy
   (C) collision orientation
   (D) all of the above
   (E) none of the above

17. The molecular geometry of the CHCl₃ molecule is __________.
   (A) bent
   (B) trigonal planar
   (C) trigonal pyramidal
   (D) tetrahedral
   (E) T-shaped
18. Of the following, _________ radiation has the shortest wavelength.
   (A) X-ray
   (B) radio
   (C) microwave
   (D) ultraviolet
   (E) infrared

19. How many grams of oxygen are in 65 g of C₂H₂O₂?
   (A) 18
   (B) 29
   (C) 9.0
   (D) 36
   (E) 130

20. The temperature of 25 °C is _________ in Kelvins.
   (A) 103
   (B) 138
   (C) 166
   (D) 248
   (E) 298

二、問答題（每題 10 分，共 20 分）

1. Given the data in the table below, \( \Delta H_{\text{rxn}} \) for the reaction
   \[
   3\text{Cl}_2(g) + \text{PH}_3(g) \rightarrow \text{PCl}_3(g) + 3\text{HCl}(g)
   \]
   is _________ kJ.

<table>
<thead>
<tr>
<th>Compound</th>
<th>( \Delta H^\circ ) [kJ/mol]</th>
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<tbody>
<tr>
<td>PCl₃(g)</td>
<td>-288.00</td>
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<tr>
<td>HCl(g)</td>
<td>-92.30</td>
</tr>
<tr>
<td>PH₃(g)</td>
<td>5.40</td>
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</tbody>
</table>

2. Draw the Lewis structure of ICl₂⁺.