1. Which of the following reaction(s) will result in a positive change in entropy?
I: The formation of gaseous water
II: The combustion of ethanol (C₂H₅OH)
III: The decomposition of hydrogen peroxide (H₂O₂)
(1) I only            (2) II only           (3) I and III         (4) II and III    (5) I, II and III

2. Phosphorylation, the addition of a phosphate group (Pᵢ) to an organic compound, is a common reaction that happens in your body. Given the hydrolysis of ATP and the first step in glycolysis, which of the following is true?

ATP + H₂O → ADP + Pᵢ, ΔG° = −31.0 kJ/mol

glucose + Pᵢ → glucose-6-phosphate + H₂O, ΔG° = +14.3 kJ/mol

(1) The phosphorylation of glucose drives the hydrolysis of ATP
(2) The hydrolysis of ATP drives the phosphorylation of glucose
(3) The phosphorylation of ADP drives the phosphorylation of glucose
(4) The phosphorylation of glucose drives the phosphorylation of ADP

3. Rank the following in order of increasing microstates:
(1) I, II, III  (2) II, I, III   (3) II, III, I
(4) III, II, I  (5) I, III, II

4. Consider the following reaction:
2 Hg(l) + O₂(g) → 2 HgO(s); ΔH°rxn = −90.79 kJ/mol, ΔS°rxn = +70.27 J/mol*K

Which of the following is true of the free energy change at 1020°C?

(1) ΔG° represents the maximum work the system can do
(2) ΔG° represents the minimum work the system can do
(3) ΔG° represents the maximum work the system requires
(4) ΔG° represents the minimum work the system requires

5. Which of the following is/are true?
I: An exothermic reaction has a positive ΔS_surroundings
II: An increase in temperature will decrease ΔS_surroundings
III: For a spontaneous reaction, the ΔS_universe will decrease
(1) only I          (2) only II    (3) I and II     (4) II and III    (5) I, II and III

6. Hypobromous acid is a commonly used disinfectant in swimming pools. At 25°C HBrO dissociates in water with a Kₐ = 2.3x10⁻⁹. Is this dissociation a spontaneous process when [H₃O⁺] = 6.0x10⁻⁴ M, [BrO⁻] = 0.10 M, and [HBrO] = 0.20 M?

(1) Yes, because ΔG > 0          (2) No, because ΔG > 0
(3) Yes, because ΔG < 0          (4) No, because ΔG < 0
7. Which of the following corresponds to the line notation of a voltaic cell?
I: Pt | H₂(g) | H⁺(aq) || Cu²⁺(aq) | Cu(s)
II: Na(s) | Na⁺(aq) || K⁺(aq) | K(s)
III: Fe(s) | Fe²⁺(aq) || Zn²⁺(aq) | Zn(s)
(1) I only  (2) II only  (3) III only  (4) I and II  (5) II and III

8. Which of the following is/are true given the following reaction?
3 Ni(s) + ClO₃⁻(aq) + 6 H⁺(aq) \rightarrow 3 Ni²⁺(aq) + Cl⁻(aq) + 3 H₂O(l) with a NaCl salt bridge present
I: The electrode in the anode gains mass
II: Na⁺(aq) flows from the salt bridge into the half-cell containing ClO₃⁻/Cl⁻
III: Electrons move from the half-cell containing ClO₃⁻/Cl⁻ to the half-cell containing Ni/Ni²⁺
(1) I only       (2) II only  (3) I and II  (4) II and III  (5) I and III

9. If the cell potential is 0.87 V for the following cell:
Cu(s) | Cu²⁺(0.90 M) || Br⁻ (saturated MBr₂) | Br₂(l) | Pt(s), what is the K_sp of MBr₂? (M = metal)
(1) 4.9x10⁻⁷  (2) 9.9x10⁻³  (3) 9.8x10⁻⁵  (4) 3.9x10⁻⁶  (5) 3.1x10⁻⁵

10. How many of the following metals would be spontaneously dissolved by 1.0M HBr?
I: Zn(s)  II: Al(s)  III: Cu(s)  IV: Pb(s)  V: I₂(s)
(1) zero       (2) one  (3) two  (4) three  (5) four

11. Rank the following oxidizing agents in order of decreasing strength:
I: NO₃⁻(aq) + 4H⁺(aq) + 3e⁻ \rightarrow NO(g) + 2H₂O(l)  \quad E^\circ = +0.96 V
II: N₂(g) + 5H⁺(aq) + 4e⁻ \rightarrow N₂H₅⁺ (aq)   \quad E^\circ = -0.23 V
III: MnO₂(s) + 4H⁺(aq) + 2e⁻ \rightarrow Mn²⁺(aq) + 2H₂O(l)  \quad E^\circ = +1.23 V
(1) N₂ > NO₃⁻ > MnO₂     (2) MnO₂ > NO₃⁻ > N₂     (3) N₂H₅⁺ > NO > Mn²⁺  (4) Mn²⁺ > NO > N₂H₅⁺

12. Given the following half reactions, which of the following is/are true?
Zr⁴⁺(aq) + 4e⁻ \rightarrow Zr(s)  \quad E_{cell} = -1.53 V
O₂(g) + 4H⁺(aq) + 4e⁻ \rightarrow 2H₂O(l)  \quad E_{cell} = +1.23 V
I: Coating the Zr electrode with zinc will prevent it from corrosion
II: At a pH = 6 there is a faster rate of corrosion than at a pH = 8
(1) I only       (2) II only  (3) Both  (4) Neither

13. A current is applied to a molten mixture containing KI and MgF₂. Which of the following would be the products formed at the anode and cathode, respectively?
(1) I₂(g), Mg(l)  (2) I₂(g), K(s)  (3) F₂(g), Mg(l)  (4) F₂(g), K(s)  (5) none

14. A current of 11.3 A is applied to 1.25 L of a solution of 0.552 M HBr converting some of the H⁺ to H₂(g), which bubbles out of solution. What is the pH of the solution after 73 minutes?
(1) 0.161  (2) 0.258  (3) 0.387  (4) 0.669  (5) 0.849