

CHEM-1212
Spring 2015
Third Examination
Form A

Use the Standard Electrode Potentials at 25°C on the questions below as needed.

| Reduction Half-Reaction | $E^\circ(\text{V})$ |
|--|---------------------|
| $\text{Au}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s})$ | + 1.50 |
| $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$ | + 1.33 |
| $\text{Br}_2(\text{l}) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$ | + 1.06 |
| $\text{NO}_3^-(\text{aq}) + 4\text{H}^+(\text{aq}) + 3\text{e}^- \rightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ | + 0.96 |
| $\text{ClO}_2(\text{g}) + \text{e}^- \rightarrow \text{ClO}_2^-(\text{aq})$ | + 0.95 |
| $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$ | + 0.80 |
| $\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$ | + 0.77 |
| $\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$ | + 0.54 |
| $\text{Cu}^+(\text{aq}) + \text{e}^- \rightarrow \text{Cu}(\text{s})$ | + 0.52 |
| $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$ | + 0.34 |
| $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$ | 0 (defined) |
| $\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pb}(\text{s})$ | - 0.13 |
| $\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$ | - 0.14 |
| $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$ | - 0.44 |
| $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$ | - 0.76 |
| $\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}(\text{s})$ | - 1.18 |
| $\text{K}^+(\text{aq}) + \text{e}^- \rightarrow \text{K}(\text{s})$ | - 2.92 |

Multiple Choice - Choose the BEST Answer

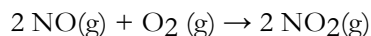
1. Indicate the order of reaction that would be consistent with the following observations:

I) A plot of the $1/[\text{reactant}]$ versus time yields a straight line.

II) The half-life of the reaction gets longer as the initial concentration is increased.

- A) zero order
- B) first order
- C) second order
- D) There is not enough information to narrow it down to one order.
- E) The information given belongs to different orders.

2. Consider the following equation:



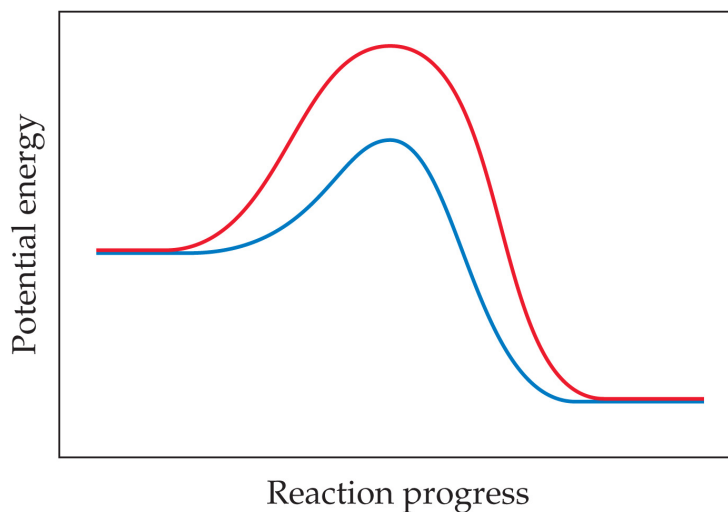
The initial rate of reaction is measured at several different concentrations of the reactants with the following results:

| [NO] (M) | [O ₂] (M) | Initial Rate (M ⁻¹ s ⁻¹) |
|----------|-----------------------|---|
| 0.030 | 0.0055 | 8.55 x 10 ⁻³ |
| 0.030 | 0.0110 | 1.71 x 10 ⁻² |
| 0.060 | 0.0055 | 3.42 x 10 ⁻² |

From the data above, which of the following is the correct rate law and the rate constant for the reaction?

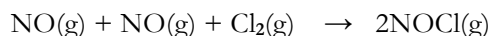
- A) Rate = 57 M⁻¹s⁻¹[NO][O₂]
- B) Rate = 3.8 M^{-1/2}s⁻¹[NO][O₂]^{1/2}
- C) Rate = 3.1 x 10⁵ M⁻³s⁻¹[NO][O₂]²
- D) Rate = 1.7 x 10³ M⁻²s⁻¹[NO]²[O₂]
- E) Rate = 9.4 x 10³ M⁻²s⁻¹[NO][O₂]²

3. The following graph shows two different reaction pathways for the same overall reaction at the same temperature. Which of the following statements is **false**?

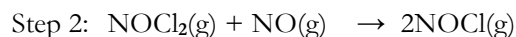
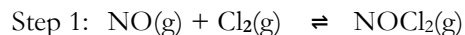


- A) The rate is slower for the top path than for the bottom path.
- B) For both paths, the rate of the reverse reaction is slower than the rate of the forward reaction.
- C) The energy difference between reactants and products is the same for both paths.
- D) For both paths, the reaction is endothermic.
- E) For both paths, the reverse reaction is more sensitive to temperature.

4. The following reaction has been shown experimentally to occur in more than one step:



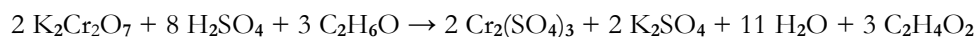
The mechanism is thought to occur in two elementary steps shown below:



The experiments performed showed that rate law was second order in [NO] and third order overall. Which of the following statements are correct about the mechanism?

- A) The first step is the slow step; the second step is the fast step. This means that the second step is primarily used to determine the rate law.
- B) The first step is the slow step; the second step is the fast step. This means that the first step is primarily used to determine the rate law.
- C) The first step is the fast step; the second step is the slow step. This means that the second step is primarily used to determine the rate law.
- D) The first step is the fast step; the second step is the slow step. This means that the first step is primarily used to determine the rate law.
- E) The second step is the slow step; therefore, it is the only step necessary for the reaction to take place.

5. The reaction that occurs in a Breathalyzer, a device used to determine the alcohol level in a person's bloodstream, is given below. If the rate of appearance of $\text{Cr}_2(\text{SO}_4)_3$ is 1.64 mol/min at a particular moment, what is the rate of disappearance of $\text{C}_2\text{H}_6\text{O}$ at that moment?



- A) 0.547 mol/min
- B) 1.09 mol/min
- C) 2.46 mol/min
- D) 4.92 mol/min
- E) 0.273 mol/min

6. Which of the following statements is true regarding average reaction rates and instantaneous reaction rate?

- A) An instantaneous rate is found at a particular moment during a reaction.
- B) An average reaction rate is determined using long periods of time during the reaction
- C) Instantaneous reaction rates usually decrease during the course of a reaction.
- D) Both A and B
- E) All of the above.

7. The first-order reaction, $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$, has a rate constant equal to $2.20 \times 10^{-5} \text{ s}^{-1}$ at 593 K. What percentage of the initial amount of SO_2Cl_2 will remain after 6.00 hours?

- A) 1.00%
- B) 37.8%
- C) 40.2%
- D) 62.2%
- E) 1.60%

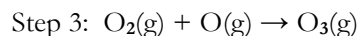
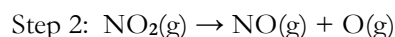
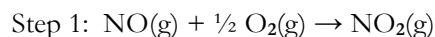
8. The following reaction has a rate law of: $\text{Rate} = k[\text{B}]^2$



If the concentration of [A] is doubled, what is the effect on the rate of the reaction?

- A) The rate quadruples.
- B) The rate doesn't change.
- C) The rate doubles
- D) The rate goes up by a factor of six.
- E) The rate decreases.

9. The following reaction is believed to occur in 3 steps:



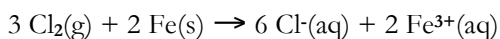
In this series of reactions, what can be classified as a catalyst?

- A) $\text{NO}_2(\text{g})$
- B) $\text{O}_2(\text{g})$
- C) $\text{O}(\text{g})$
- D) $\text{NO}(\text{g})$
- E) There is not a catalyst present in this mechanism.

10. In lab your lab partner and yourself forgot to wear gloves while working with 1 M HNO_3 (aq). You realized this part way through the lab, however your lab partner is wearing a piece of silver jewelry. Which of the following situations is most likely to occur if the solid silver (pure) touches the 1 M HNO_3 (aq)?

- A) The solid silver will spontaneously oxidize to form $\text{Ag}^+(\text{aq})$ in solution.
- B) The process would not occur under standard conditions, therefore, nothing would happen.
- C) The process would have an $E^\circ_{\text{cell}} = -0.16\text{V}$.
- D) Both B and C are correct.
- E) There is not enough information to make any of the above predictions.

11. What is the correct cell notation for the redox reaction given below?

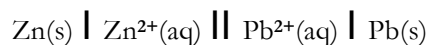


- A) $\text{Cl}_2(\text{g}) \mid \text{Cl}^-(\text{aq}) \mid \text{Pt} \parallel \text{Fe}(\text{s}) \mid \text{Fe}^{3+}(\text{aq})$
- B) $\text{Cl}^-(\text{aq}) \mid \text{Cl}_2(\text{g}) \mid \text{Pt} \parallel \text{Fe}^{3+}(\text{aq}) \mid \text{Fe}(\text{s})$
- C) $\text{Pt} \mid \text{Fe}^{3+}(\text{aq}) \mid \text{Fe}(\text{s}) \parallel \text{Cl}^-(\text{aq}) \mid \text{Cl}_2(\text{g})$
- D) $\text{Fe}(\text{s}) \mid \text{Cl}_2(\text{g}) \parallel \text{Fe}^{3+}(\text{aq}) \mid \text{Cl}^-(\text{aq}) \mid \text{Pt}$
- E) $\text{Fe}(\text{s}) \mid \text{Fe}^{3+}(\text{aq}) \parallel \text{Cl}_2(\text{g}) \mid \text{Cl}^-(\text{aq}) \mid \text{Pt}$

12. A galvanic cell was made using the redox couples Ag^+/Ag and Pb^{2+}/Pb . What species are produced at the electrodes under standard conditions?

- A) $\text{Ag}(\text{s})$ is formed at the cathode and $\text{Pb}(\text{s})$ is formed at the anode.
- B) $\text{Ag}(\text{s})$ is formed at the cathode and $\text{Pb}^{2+}(\text{aq})$ is formed at the anode.
- C) $\text{Pb}(\text{s})$ is formed at the cathode and $\text{Ag}^+(\text{aq})$ is formed at the anode.
- D) $\text{Pb}^{2+}(\text{aq})$ is formed at the cathode and $\text{Ag}^+(\text{aq})$ is formed at the anode.
- E) $\text{Ag}^+(\text{aq})$ is formed at the cathode and $\text{Pb}^{2+}(\text{aq})$ is formed at the anode.

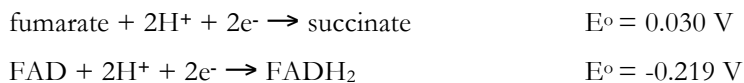
13. A galvanic cell was made using the following cell notation:



Which one of the following changes to the cell would cause the cell potential to increase?

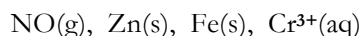
- A) increase the $[\text{Zn}^{2+}]$ concentration
- B) increase the $[\text{Pb}^{2+}]$ concentration
- C) increase the mass of $\text{Zn}(\text{s})$
- D) decrease the mass of $\text{Zn}(\text{s})$
- E) increase the mass of $\text{Pb}(\text{s})$

14. Which of the following statements is true regarding the oxidation of succinate by FAD? Use the following reduction half reactions with their reduction potentials as necessary.



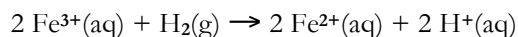
- A) H^+ is reduced by fumarate
- B) FAD is reduced by succinate
- C) In the overall reaction, two electrons are transferred for each molecule of succinate oxidized.
- D) Both B and C
- E) All of the above.

15. Rank the following ions in the order of increasing strength as reducing agents:



- A) $\text{Fe(s)} < \text{NO(g)} < \text{Cr}^{3+}(\text{aq)} < \text{Zn(s)}$
- B) $\text{Cr}^{3+}(\text{aq)} < \text{NO(g)} < \text{Fe(s)} < \text{Zn(s)}$
- C) $\text{NO(g)} < \text{Zn(s)} < \text{Fe(s)} < \text{Cr}^{3+}(\text{aq)}$
- D) $\text{Cr}^{3+}(\text{aq)} < \text{Zn(s)} < \text{NO(g)} < \text{Fe(s)}$
- E) $\text{Zn(s)} < \text{Fe(s)} < \text{NO(g)} < \text{Cr}^{3+}(\text{aq)}$

16. A galvanic cell is made using the following reaction:



The cell potential is found to be 1.16 V when $[\text{Fe}^{3+}] = 0.35 \text{ M}$, $P_{\text{H}_2} = 0.95 \text{ bar}$, and $[\text{Fe}^{2+}] = 0.0010 \text{ M}$. What is the pH of the anode solution when the cell is at 298.15 K?

- A) pH = 3.04
- B) pH = 8.11
- C) pH = 7.37
- D) pH = 3.63
- E) pH = 4.06

17. The electrolysis of molten AlCl_3 for 2.50 hr with an electrical current of 15.0 A produces _____ g of aluminum metal.

- A) 113
- B) 0.466
- C) 3.50×10^3
- D) 12.6
- E) 37.8

18. Which of the following must be true for intermetallic compounds?

- A) The compound is considered a solid solution.
- B) The alloy is considered a homogeneous solution.
- C) The metal components used to form the alloy need to belong to the same group in the periodic table.
- D) The crystal structure of the alloy formed has a fixed ratio of each metal present that determines its properties.
- E) All above are correct.

19. A common mineral named orthoclase, is a tectosilicate mineral, but it does have an alternate name of potassium feldspar. It is formed when $\frac{1}{4}$ of the silicon atoms in Si_4O_8 are replaced with aluminum atoms. The charge is counterbalanced with potassium. What is the formula of this mineral?
- A) $\text{K}_2\text{AlSi}_2\text{O}_8$
 - B) KAlSi_3O_8
 - C) $\text{KAl}_2\text{Si}_2\text{O}_7$
 - D) $\text{KAl}_2\text{Si}_4\text{O}_{10}$
 - E) $\text{K}_2\text{AlSi}_3\text{O}_8$
20. Which of the following statements is (are) true about interference of two atomic orbitals?
- A) When two atomic wave functions have constructive interference, they are in phase with each other.
 - B) Even when two atomic wave functions have constructive interference, they must have similar energies to form a significantly bonding molecular orbital.
 - C) When two atomic wave functions combine to produce destructive interference, they form an antibonding molecular orbital.
 - D) When two atomic wave functions interact, they form two molecular orbitals.
 - E) All of the above statements are true.
21. Which form of the exam do you have?
- A) A
 - B) B