DO NOT OPEN THIS EXAM UNTIL INSTRUCTED.
CALCULATORS ARE NOT TO BE SHARED.

Test Form 1

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your test form number (listed above), last name, first name, middle initial, and student identification number. Leave the class section number blank.

This exam consists of 25 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form in the appropriate stack. You may keep the exam packet, so please show your work and mark the answers you selected on it.

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Stable region?
Spectrochemical series: $\text{CN}^- > \text{NO}_2^- > \text{en} > \text{NH}_3 > \text{NCS}^- > \text{H}_2\text{O} > \text{F}^- > \text{Cl}^-$

$F = 96,485 \text{ C/mole e}^-$

$N_A = 6.02 \times 10^{23}$
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<th>Acidic Solution</th>
<th>$E^\circ$, volt</th>
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<tr>
<td>$\text{F}_2(g) + 2e^- \rightarrow 2\text{F}^-(aq)$</td>
<td>+2.866</td>
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<td>$\text{O}_3(g) + 2\text{H}^+(aq) + 2e^- \rightarrow \text{O}_2(g) + \text{H}_2\text{O(l)}$</td>
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<td>$\text{S}_2\text{O}_8^{2-}(aq) + 2e^- \rightarrow 2\text{SO}_4^{2-}(aq)$</td>
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<tr>
<td>$\text{H}_2\text{O}_2(aq) + 2\text{H}^+(aq) + 2e^- \rightarrow 2\text{H}_2\text{O(l)}$</td>
<td>+1.763</td>
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<tr>
<td>$\text{MnO}_4^-(aq) + 8\text{H}^+(aq) + 5e^- \rightarrow \text{Mn}^{2+}(aq) + 4\text{H}_2\text{O(l)}$</td>
<td>+1.51</td>
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<tr>
<td>$\text{PbO}_2(s) + 4\text{H}^+(aq) + 2e^- \rightarrow \text{Pb}^{2+}(aq) + 2\text{H}_2\text{O(l)}$</td>
<td>+1.455</td>
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<td>$\text{Cl}_2(g) + 2e^- \rightarrow 2\text{Cl}^-(aq)$</td>
<td>+1.358</td>
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<tr>
<td>$\text{Cr}_2\text{O}_7^{2-}(aq) + 14\text{H}^+(aq) + 6e^- \rightarrow 2\text{Cr}^{3+}(aq) + 7\text{H}_2\text{O(l)}$</td>
<td>+1.33</td>
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<td>$\text{MnO}_2(s) + 4\text{H}^+(aq) + 2e^- \rightarrow \text{Mn}^{2+}(aq) + 2\text{H}_2\text{O(l)}$</td>
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<td>$\text{O}_2(g) + 4\text{H}^+(aq) + 4e^- \rightarrow 2\text{H}_2\text{O(l)}$</td>
<td>+1.229</td>
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<td>$2\text{IO}_3^-(aq) + 12\text{H}^+(aq) + 10e^- \rightarrow 2\text{I}_2(s) + 6\text{H}_2\text{O(l)}$</td>
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<td>$\text{Br}_2(l) + 2e^- \rightarrow 2\text{Br}^-(aq)$</td>
<td>+1.065</td>
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<td>$\text{NO}_3^-(aq) + 4\text{H}^+(aq) + 3e^- \rightarrow \text{NO(g)} + 2\text{H}_2\text{O(l)}$</td>
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<tr>
<td>$\text{Ag}^+(aq) + e^- \rightarrow \text{Ag(s)}$</td>
<td>+0.800</td>
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<td>$\text{Fe}^{3+}(aq) + e^- \rightarrow \text{Fe}^{2+}(aq)$</td>
<td>+0.771</td>
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<td>$\text{O}_2(g) + 2\text{H}^+(aq) + 2e^- \rightarrow \text{H}_2\text{O}_2(aq)$</td>
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<td>$\text{I}_2(s) + 2e^- \rightarrow 2\text{I}^-(aq)$</td>
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<td>$\text{Cu}^{2+}(aq) + 2e^- \rightarrow \text{Cu(s)}$</td>
<td>+0.340</td>
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<td>$\text{SO}_4^{2-}(aq) + 4\text{H}^+(aq) + 2e^- \rightarrow 2\text{H}_2\text{O(l)} + \text{SO}_2(g)$</td>
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<td>$\text{Sn}^{4+}(aq) + 2e^- \rightarrow \text{Sn}^{2+}(aq)$</td>
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<td>$\text{S}(s) + 2\text{H}^+(aq) + 2e^- \rightarrow \text{H}_2\text{S(g)}$</td>
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<td>$2\text{H}^+(aq) + 2e^- \rightarrow \text{H}_2(g)$</td>
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<td>$\text{Pb}^{2+}(aq) + 2e^- \rightarrow \text{Pb(s)}$</td>
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<td>$\text{Sn}^{2+}(aq) + 2e^- \rightarrow \text{Sn(s)}$</td>
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<td>$\text{Co}^{2+}(aq) + 2e^- \rightarrow \text{Co(s)}$</td>
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<td>$\text{Fe}^{2+}(aq) + 2e^- \rightarrow \text{Fe(s)}$</td>
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<td>$\text{Zn}^{2+}(aq) + 2e^- \rightarrow \text{Zn(s)}$</td>
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<td>$\text{Al}^{3+}(aq) + 3e^- \rightarrow \text{Al(s)}$</td>
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<td>$\text{Mg}^{2+}(aq) + 2e^- \rightarrow \text{Mg(s)}$</td>
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<td>$\text{Na}^+(aq) + e^- \rightarrow \text{Na(s)}$</td>
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<td>$\text{Ca}^{2+}(aq) + 2e^- \rightarrow \text{Ca(s)}$</td>
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<td>$\text{K}^+(aq) + e^- \rightarrow \text{K(s)}$</td>
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<tr>
<td>$\text{Li}^+(aq) + e^- \rightarrow \text{Li(s)}$</td>
<td>-3.040</td>
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<td><strong>Basic Solution</strong></td>
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<td>$\text{O}_3(g) + \text{H}_2\text{O(l)} + 2e^- \rightarrow \text{O}_2(g) + 2\text{OH}^-(aq)$</td>
<td>+1.246</td>
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<td>$\text{OCl}^-(g) + \text{H}_2\text{O(l)} + 2e^- \rightarrow \text{Cl}^-(aq) + 2\text{OH}^-(aq)$</td>
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<td>$\text{O}_2(g) + 2\text{H}_2\text{O(l)} + 4e^- \rightarrow 4\text{OH}^-(aq)$</td>
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<td>$2\text{H}_2\text{O(l)} + 2e^- \rightarrow \text{H}_2(g) + 2\text{OH}^-(aq)$</td>
<td>-0.828</td>
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1. The oxidation number of each vanadium in K$_2$V$_2$O$_6$ is:

(A) +2
(B) +3
(C) +4
(D) +5
(E) +6

2. Consider a "General Chemistry Battery" in which one beaker contains aqueous copper sulfate (CuSO$_4$) and a copper metal electrode and the other beaker contains aqueous zinc sulfate (ZnSO$_4$) and a zinc metal electrode.

Which of the following statements is **false**?

- (A) The mass of the copper electrode will increase as the process proceeds. $\text{Cu}^{2+}(aq) + 2e^- \rightarrow \text{Cu}^0(s)$
- (B) A wire is used to allow the flow of ions but restrict the flow of electrons. **False**
- (C) The concentration of Zn$^{2+}$ (aq) increases as the process proceeds. $\text{Zn}^0(s) \rightarrow \text{Zn}^{2+}(aq) + 2e^-$
- (D) Electrons flow from the zinc beaker to the copper beaker.
- (E) The theoretical cell voltage is 1.103 V

\[ \text{Cu}^{2+}(aq) + 2e^- \rightarrow \text{Cu}^0(s) \quad +0.340 \]
\[ \text{Zn}^{2+}(aq) + 2e^- \rightarrow \text{Zn}^0(s) \quad -0.763 \]
\[ \text{difference is} \quad 1.103 \text{ V} \]

3. Consider the reaction Cl$_2$ (g) + 2 Ag (s) → 2 Cl$^-$ (aq) + 2 Ag$^+$ (aq). The species being oxidized is:

- (A) Cl$_2$ (g)
- (B) Ag (s)
- (C) Cl$^-$ (aq)
- (D) Ag$^+$ (aq)

2 Ag$^0$(s) → 2 Ag$^+$ (aq) + 2 e$^-$

oxidized - losing 2 e$^-$
4. Consider fuel cells. Which of the following is false?

(A) A hydrogen fuel cell produces energy.
(B) The hydrogen fuel cell demonstrated in class produced water.
(C) The hydrogen fuel cell demonstrated in class contains platinum to facilitate the process.
(D) The fuel cell consists of tiny chambers that allow hydrogen gas to explode.
(E) The hydrogen fuel cell demonstrated in class input hydrogen and oxygen gases.

5. The calculated cell potential for the \( \text{Sn}(s) + \text{Br}_2(l) \rightarrow 2 \text{Br}^- (aq) + \text{Sn}^{2+} (aq) \) cell is:

\[
\begin{align*}
\text{(A)} & \quad +1.100 \text{ V} \\
\text{(B)} & \quad +1.339 \text{ V} \\
\text{(C)} & \quad 0.791 \text{ V} \\
\text{(D)} & \quad 0.928 \text{ V} \\
\text{(E)} & \quad +1.202 \text{ V}
\end{align*}
\]

\[
\begin{align*}
\text{Br}_2(l) + 2e^- & \rightarrow 2 \text{Br}^- (aq) \\
\text{Sn}^{2+} (aq) + 2e^- & \rightarrow \text{Sn}^0 (s)
\end{align*}
\]

\[
\begin{align*}
\text{difference} & \quad +1.065 \\
\text{is} & \quad -0.137 \\
\text{1.202 V}
\end{align*}
\]

6. A student provides a current of 4.50 amps through an aqueous solution of \( \text{Cu}^{2+} (aq) \) for 2.00 hours. The voltage is such that copper metal is plated. The mass of copper deposited is:

\[
\begin{align*}
\text{(A)} & \quad 7.85 \text{ g} \\
\text{(B)} & \quad 10.7 \text{ g} \\
\text{(C)} & \quad 2.73 \text{ g} \\
\text{(D)} & \quad 12.73 \text{ g} \\
\text{(E)} & \quad 37.9 \text{ g}
\end{align*}
\]

\[2.00 \text{ h} \left( \frac{3600 \text{ s}}{1 \text{ h}} \right) \left( \frac{4.50 \text{ C}}{1 \text{ mol e}^-} \right) \left( \frac{1 \text{ mol Cu}}{63.546 \text{ g}} \right) \times \left( \frac{2 \text{ mol e}^-}{1 \text{ mol Cu}} \right) = 10.7 \text{ g Cu}\]
7. Consider $\text{Na}^+ (\text{aq})$, $\text{Pb}^{2+} (\text{aq})$, $\text{Zn}^{2+} (\text{aq})$, $\text{Ag}^+ (\text{aq})$, and $\text{Li}^+ (\text{aq})$. The strongest oxidizing agent is:

(A) $\text{Na}^+ (\text{aq})$
(B) $\text{Pb}^{2+} (\text{aq})$
(C) $\text{Zn}^{2+} (\text{aq})$
(D) $\text{Ag}^+ (\text{aq})$
(E) $\text{Li}^+ (\text{aq})$

8. When the reaction $\text{Fe} (s) + \text{Cr}_2\text{O}_7^{2-} (\text{aq}) \rightarrow \text{Cr}^{2+} (\text{aq}) + \text{Fe}^{3+} (\text{aq})$ is correctly balanced in acid,

(A) 3 protons ($\text{H}^+$) are consumed
(B) 7 protons ($\text{H}^+$) are consumed
(C) 8 protons ($\text{H}^+$) are consumed
(D) 12 protons ($\text{H}^+$) are consumed
(E) 42 protons ($\text{H}^+$) are consumed

\[
\left[ \text{Fe}^0 (s) \rightarrow \text{Fe}^{3+} (\text{aq}) + 3 \text{e}^- \right] \times 8
\]
\[
\left[ 8 \text{e}^- + 14 \text{H}^+ + \text{Cr}_2\text{O}_7^{2-} \rightarrow 2 \text{Cr}^{2+} + 7 \text{H}_2\text{O} \right] \times 3
\]

\[
8 \text{ Fe}^0 (s) + 2 \times 8 \text{e}^- + 42 \text{H}^+ + 3 \text{Cr}_2\text{O}_7^{2-} \rightarrow 8 \text{ Fe}^{3+} + 24 \text{e}^- + 6 \text{Cr}^{2+} + 21 \text{H}_2\text{O}
\]
9. \(^{247}\text{Bk}^{2+}\) has:

(A) 97 protons, 247 neutrons, 99 electrons
(B) 150 protons, 97 neutrons, 99 electrons
(C) 97 protons, 150 neutrons, 95 electrons
(D) 247 protons, 247 neutrons, 95 electrons
(E) 247 protons, 238 neutrons, 95 electrons

10. Th-234 decays to produce a beta particle and

(A) Ra-230
(B) Th-233
(C) Th-235
(D) U-238
(E) Pa-234

\[ ^{234}\text{Th} \rightarrow ^{0}\beta + ^{234}\text{Pa} \]

11. Gd-150 decays to produce an alpha particle and

(A) Gd-146
(B) Tb-150
(C) Tb-146
(D) Sm-150
(E) Sm-146

\[ ^{150}\text{Gd} \rightarrow 2\ \alpha + ^{146}\text{Sm} \]

12. When a beta particle is emitted,

(A) An electron is converted to a helium nucleus.
(B) A gamma ray is released.
(C) Two gamma rays are released.
(D) A proton is converted to a neutron.
(E) A neutron is converted to a proton.

\[ ^{0}\text{n} \rightarrow ^{0}\beta + ^{1}\text{p} \]
13. A student isolates a sample of tritium ($t_{1/2} = 12.26$ y) containing 5,000 atoms. How much time must pass for only 625 tritium atoms to remain?

(A) 36.8 y  
(B) 24.5 y  
(C) 12.3 y  
(D) 46.2 y  
(E) 43.6 y

\[ \ln \frac{5000 \text{ atoms}}{625 \text{ atoms}} = - (0.0565 \text{ y}^{-1}) t \]
\[ 0.6931 = -(0.0565 \text{ y}^{-1}) t \]
\[ t = \frac{0.6931}{0.0565 \text{ y}^{-1}} = 12.26 \text{ y} \]

14. Considering the carbon cycle and radiocarbon dating, which of the following statements is **false**?

(A) The carbon-14 concentration in fossils is less than the carbon-14 concentration in you.  
(B) **Carbon-14 in living organisms does not undergo decay.** It does and it is not replenished.  
(C) Carbon-14 can be used to date specimens previously in the carbon cycle.  
(D) Carbon-14 is generated in the upper atmosphere.

15. Considering nuclear chemistry, which of the following statements is **false**?

(A) An example of nuclear fusion is $^1_1\text{H} + ^2_1\text{H} \rightarrow ^3_2\text{He}$.  
(B) An example of nuclear fission is $^1_0\text{n} + ^{235}_{92}\text{U} \rightarrow ^{137}_{52}\text{Te} + ^{97}_{40}\text{Zr} + 2 ^1_0\text{n}$.  
(C) The half-life is the time required for a sample to decay to one-half its original amount.  
(D) **Gamma radiation has a mass of -1.**  
(E) A Geiger Counter can be used to show that the orange pigment in certain ceramic glazes is radioactive.
16. Which of the following correctly depicts the curve of nuclear binding energy?

(A) ![Diagram A](image)

(B) ![Diagram B](image)

(C) ![Diagram C](image)

(D) ![Diagram D](image)

17. Consider the band of stability (AKA "Belt of Stability" located near the beginning of the exam). What decay is expected for a species located to the left of the belt?

(A) Alpha decay
(B) Beta decay
(C) Gamma decay
(D) Social decay
(D) UK decay

\[ n \rightarrow p + \gamma \]
18. A radioactive decay series that begins with $^{238}\text{U}$ ends with formation of the stable nuclide $^{206}\text{Pb}$. How many alpha particle emissions and how many beta particle emissions are involved in the sequence of radioactive decays?

(A) 6 alpha and 8 beta decays
(B) 6 alpha and 6 beta decays
(C) 8 alpha and 8 beta decays
(D) 8 alpha and 6 beta decays
(E) 8 alpha and 2 beta decays

19. The complex:

\[
\begin{array}{c}
\text{Cl} \\
\text{F} \\
\text{Cu} \\
\text{F} \\
\text{Cl} \\
\end{array}
\]

(A) is cis-$[\text{CuCl}_3\text{F}_3]^{4-}$
(B) is trans-$[\text{CuCl}_3\text{F}_3]^{4-}$
(C) is fac-$[\text{CuCl}_3\text{F}_3]^{4-}$
(D) is mer-$[\text{CuCl}_3\text{F}_3]^{4-}$

20. Consider coordination chemistry. Which of the following is false?

(A) trans-$[\text{FeF}_3\text{Cl}_4]^{3-}$ is nonpolar
(B) $[\text{CuF}_6]^{3-}$ is a square planar complex Octahedral
(C) $\text{C}_2\text{O}_4^{2-}$ (ox; the oxalate ion) is a Lewis Base
(D) $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ (en; ethylenediamine) is a bidentate
(E) $\text{F}^-$ is a Lewis Base
21. The coordination number for Fe in [Fe(ox)₃]³⁻ is:
   (A) 1
   (B) 2
   (C) 3
   (D) 4
   (E) 6

22. How many d-electrons does Fe³⁺ have?
   (A) 3
   (B) 5
   (C) 7
   (D) 8
   (E) 9

23. Consider [Pt(NH₃)₂Cl₂]. Which of the following is false?
   (A) [Pt(NH₃)₂Cl₂] is square planar ✓
   (B) [Pt(NH₃)₂Cl₂] has mer- and fac- isomers ✓
   (C) cis-[Pt(NH₃)₂Cl₂] is polar ✓
   (D) The coordination number for Pt in [Pt(NH₃)₂Cl₂] is 4 ✓
   (E) trans-[Pt(NH₃)₂Cl₂] is non-polar ✓
24. How many unpaired electrons are present in \([\text{Mn(CN)}_6]^{4+}\)?
[Mn is the Mn\(^{2+}\) ion; CN is the CN\(^-\) ion; and the Mn\(^{2+}\) is low spin.]

(A) 0
(B) 1
(C) 2
(D) 3
(E) 5

25. The CH 123 Final Exam is scheduled for Monday, June 7, 2010, 4:00-5:50pm. Which one of the following statements is **FALSE**?

(A) The CH 123 Final Exam is scheduled for Monday, June 7, 2010, 4:00-5:50pm
(B) The CH 123 Final Exam is scheduled for Monday, June 7, 2010, 4:00-5:50pm
(C) The CH 123 Final Exam is scheduled for Monday, June 7, 2010, 4:00-5:50pm
(D) The CH 123 Final Exam is scheduled for Monday, June 7, 2010, 4:00-5:50pm
(E) Your chemistry notes cannot impress your mother enough to entice her into writing a check for $1000.

[Any response will receive full credit; even no response.]