Chemistry 123 | Spring 2007 | Oregon State University
Exam 2 | May 24, 2007 | Dr. Richard Nafshun

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

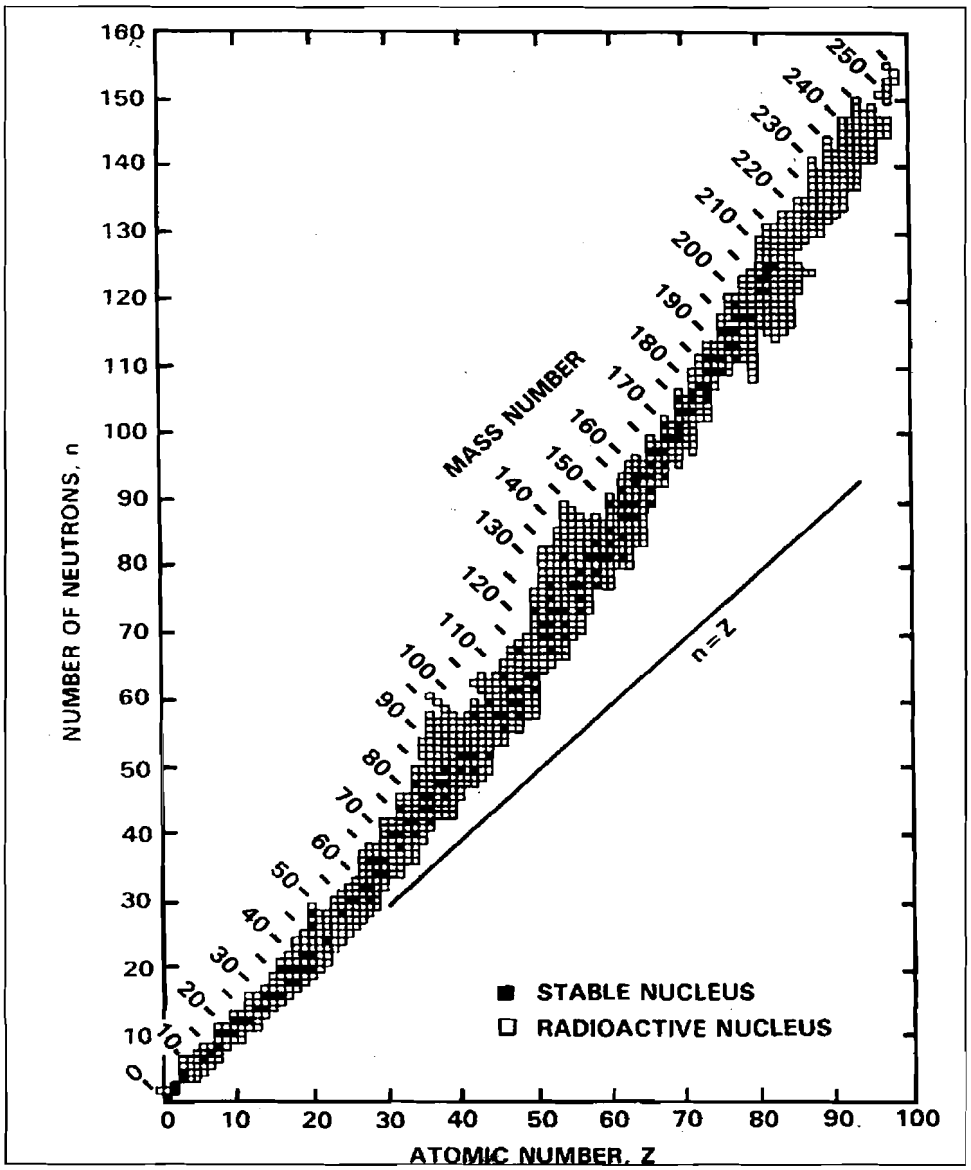
**Test Form 1**

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.

| Reduction Half-Reaction | $E^\circ$, volt |
|---|---|
| **Acidic Solution** | |
| $F_2\ (g) + 2\ e^- \rightarrow 2F^-\ (aq)$ | +2.866 |
| $O_3(g) + 2\ H^+(aq) + 2\ e^- \rightarrow O_2\ (g) + H_2O(l)$ | +2.075 |
| $S_2O_8^{2-}\ (aq) + 2\ e^- \rightarrow 2\ SO_4^{2-}\ (aq)$ | +2.01 |
| $H_2O_2\ (aq) + 2H^+\ (aq) + 2\ e^- \rightarrow 2\ H_2O(l)$ | +1.763 |
| $MnO_4^-(aq) + 8H^+\ (aq) + 5\ e^- \rightarrow Mn^{2+}(aq) + 4\ H_2O(l)$ | +1.51 |
| $PbO_2\ (s) + 4H^+\ (aq) + 2\ e^- \rightarrow Pb^{2+}(aq) + 2\ H_2O(l)$ | +1.455 |
| $Cl_2\ (g) + 2\ e^- \rightarrow 2\ Cl^-\ (aq)$ | +1.358 |
| $Cr_2O_7^{2-}\ (aq) + 14\ H^+\ (aq) + 6\ e^- \rightarrow 2\ Cr^{3+}(aq) + 7\ H_2O(l)$ | +1.33 |
| $MnO_2(s) + 4H^+\ (aq) + 2\ e^- \rightarrow Mn^{2+}(aq) + 2\ H_2O(l)$ | +1.23 |
| $O_2(g) + 4H^+\ (aq) + 4\ e^- \rightarrow 2\ H_2O(l)$ | +1.229 |
| $2\ IO_3^-\ (aq) + 12H^+\ (aq) + 10\ e^- \rightarrow I_2(s) + 6\ H_2O(l)$ | +1.20 |
| $Br_2(l) + 2\ e^- \rightarrow 2\ Br^-\ (aq)$ | +1.065 |
| $NO_3^-\ (aq) + 4H^+\ (aq) + 3\ e^- \rightarrow NO(g) + 2\ H_2O(l)$ | +0.956 |
| $Ag^+\ (aq) + e^- \rightarrow Ag(s)$ | +0.800 |
| $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ | +0.771 |
| $O_2(g) + 2H^+\ (aq) + 2\ e^- \rightarrow H_2O_2(aq)$ | +0.695 |
| $I_2(s) + 2\ e^- \rightarrow 2\ I^-\ (aq)$ | +0.535 |
| $Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$ | +0.340 |
| $SO_4^{2-}\ (aq) + 4H^+\ (aq) + 2\ e^- \rightarrow 2\ H_2O(l) + SO_2(g)$ | +0.17 |
| $Sn^{4+}\ (aq) + 2\ e^- \rightarrow Sn^{2+}\ (aq)$ | +0.154 |
| $S(s) + 2H^+\ (aq) + 2\ e^- \rightarrow H_2S(g)$ | +0.14 |
| $2H^+(aq) + 2\ e^- \rightarrow H_2(g)$ | 0 |
| $Pb^{2+}(aq) + 2\ e^- \rightarrow Pb(s)$ | -0.125 |
| $Sn^{2+}(aq) + 2\ e^- \rightarrow Sn(s)$ | -0.137 |
| $Co^{2+}(aq) + 2\ e^- \rightarrow Co(s)$ | -0.277 |
| $Fe^{2+}(aq) + 2\ e^- \rightarrow Fe(s)$ | -0.440 |
| $Zn^{2+}(aq) + 2\ e^- \rightarrow Zn(s)$ | -0.763 |
| $Al^{3+}(aq) + 3\ e^- \rightarrow Al(s)$ | -1.676 |
| $Mg^{2+}(aq) + 2\ e^- \rightarrow Mg(s)$ | -2.356 |
| $Na^+(aq) + e^- \rightarrow Na\ (s)$ | -2.713 |
| $Ca^{2+}(aq) + 2\ e^- \rightarrow Ca(s)$ | -2.84 |
| $K^+(aq) + e^- \rightarrow K(s)$ | -2.924 |
| $Li^+(aq) + e^- \rightarrow Li(s)$ | -3.040 |
| **Basic Solution** | |
| $O_3(g) + H_2O(l) + 2\ e^- \rightarrow O_2(g) + 2\ OH^-(aq)$ | +1.246 |
| $OCl^-(g) + H_2O(l) + 2\ e^- \rightarrow Cl^-(aq) + 2\ OH^-(aq)$ | +0.890 |
| $O_2(g) + 2\ H_2O(l) + 4\ e^- \rightarrow 4\ OH^-(aq)$ | +0.401 |
| $2\ H_2O(l) + 2\ e^- \rightarrow H_2(g) + 2\ OH^-(aq)$ | -0.828 |




Spectrochemical series: $CN^- > NO_2^- > en > NH_3 > NCS^- > H_2O > F^- > Cl^-$

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

$N_A = 6.02 \times 10^{23}$

1. The oxidation number of each iron in $K_6Fe_2O_6$ is:

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

+6 -12
+6 - Each must be +3

2. Consider the reaction $2\ Fe^{3+}\ (aq) + Mg\ (s) \rightarrow Mg^{2+}\ (aq) + 2\ Fe^{2+}\ (aq)$. Which statement is correct?

(A) $Fe^{3+}$ (aq) is reduced and is gaining electrons
(B) $Fe^{3+}$ (aq) is reduced and is losing electrons
(C) $Fe^{3+}$ (aq) is oxidized and is losing electrons
(D) Mg (s) is reduced and is losing electrons
(E) Mg (s) is reduced and is gaining electrons

$Fe^{3+}\ (aq)$
$Fe^{2+}\ (aq)$
reduction - gaining e⁻

3. 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 concentration of $Zn^{2+}$ (aq) increases as the process proceeds.
(B) Electrons flow from the zinc beaker to the copper beaker.
(C) $Cu^{2+}$ (aq) is oxidized.
(D) A salt bridge is needed to allow the flow of ions.
(E) The mass of the copper electrode will increase as the process proceeds.

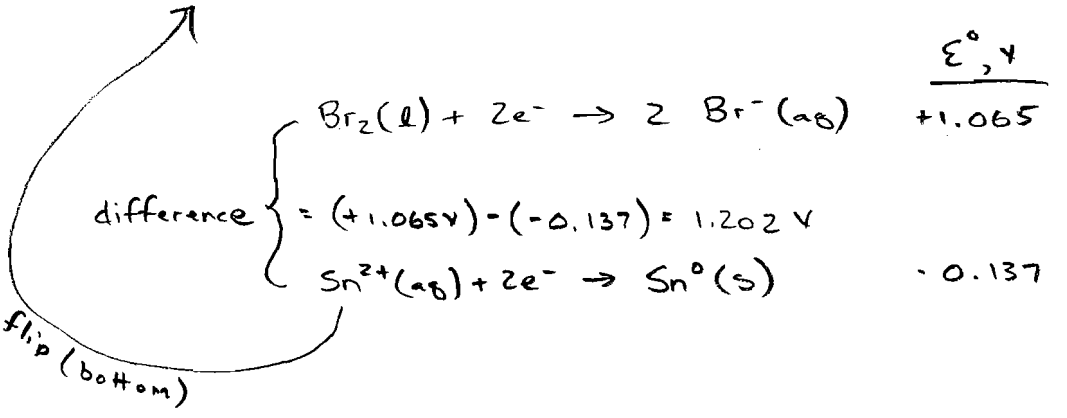
$Cu^{2+} + 2e^- \rightarrow Cu^0$ $Cu^{2+}$ is reduced - gaining e⁻

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 $Sn(s) + Br_2(l) \rightarrow 2\ Br^-(aq) + Sn^{2+}(aq)$ cell is:

(A) + 1.100 V
(B) + 1.339 V
(C) + 0.791 V
(D) + 0.928 V
(E) + 1.202 V




6. A student provides a current of 1.500 amps through an aqueous solution of $Cu(NO_3)_2$ for 7.000 hours. The voltage is such that copper is deposited at the cathode. The mass of copper deposited is:

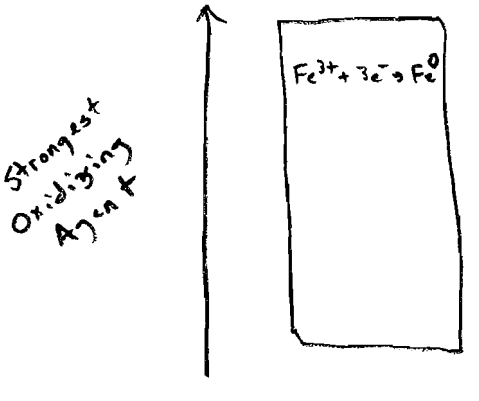
(A) 0.0804 g.
(B) 0.1608 g.
(C) 6.222 g.
(D) 12.44 g.
(E) 24.89 g.

$$7.000\ h \left(\frac{3600\ s}{1\ h}\right)\left(\frac{1.500\ C}{1\ s}\right)\left(\frac{1\ mol\ e^-}{96{,}485\ C}\right)\left(\frac{1\ mol\ Cu}{2\ mol\ e^-}\right)\left(\frac{63.546\ g}{1\ mol\ Cu}\right) = 12.44\ g$$

1.500 Amps ↑ F ↑ $Cu^{2+} + 2e^- \rightarrow Cu^0$

7. Consider $Fe^{3+}$ (aq), $Al^{3+}$ (aq), $Mg^{2+}$ (aq), $Na^+$ (aq), and $Li^+$ (aq). The strongest oxidizing agent is:

(A) $Fe^{3+}$ (aq)
(B) $Al^{3+}$ (aq)
(C) $Mg^{2+}$ (aq)
(D) $Na^+$ (aq)
(E) $Li^+$ (aq)



8. When the reaction $NO_3^-$ (aq) + Zn (s) → $NH_4^+$ (aq) + $Zn^{2+}$ (aq) is correctly balanced in acid,

(A) 2 protons ($H^+$) are consumed
(B) 4 protons ($H^+$) are consumed
(C) 6 protons ($H^+$) are consumed
(D) 8 protons ($H^+$) are consumed
(E) 10 protons ($H^+$) are consumed

$\{ Zn^0(s) \rightarrow Zn^{2+}(aq) + 2e^- \} \times 4$

$8e^- + 10H^+(aq) + NO_3^-(aq) \rightarrow NH_4^+(aq) + 3H_2O(l)$

+9 +1

$4Zn^0(s) + 8e^- + 10H^+(aq) + NO_3^-(aq) \rightarrow 4Zn^{2+}(aq) + 8e^- + NH_4^+(aq) + 3H_2O(l)$

9. When a beta particle is emitted,

(A) An X-ray is released.
(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.

$n \rightarrow p + e^-$

↑

$\beta$ particle

10. The mode of decay that is unaffected by a magnetic field is:

(A) Alpha emission
(B) Beta emission
(C) Gamma emission

$^{0}_{0}\gamma$ EM

11. Gd-150 decays to produce a beta particle and _____.

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

$^{150}_{64}Gd \rightarrow {}^{0}_{-1}\beta + {}^{150}_{65}Tb$

12. U-235 decays to produce an alpha particle and _____.

(A) Pa-235
(B) Th-235
(C) Th-231
(D) U-238
(E) Np-235

$^{235}_{92}U \rightarrow {}^{4}_{2}\alpha + {}^{231}_{90}Th$

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

(A) A Geiger counter can be used to detect α-decay ✓
(B) Radioactive decay is a first-order decay process ✓
(C) The half-life is the time required for a sample to decay to one-half its original amount ✓
(D) The orange pigment in certain ceramic glazes appears to be radioactive ✓
(E) $^{60m}Co$ is not radioactive

$^{60m}_{27}Co \rightarrow {}^{60}_{27}Co + 2\,{}^{0}_{0}\gamma$

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
(C) Carbon-14 can be used to date specimens previously in the carbon cycle ✓
(D) Carbon-14 is generated in the upper atmosphere ✓

15. A student obtains a sample of C-11 ($t_{1/2}$ = 20.39 minutes) containing 1.000 g. How long will it take for the sample to decay to 0.723 g of C-11?

(A) 8.54 minutes.
(B) 9.04 minutes.
(C) 9.54 minutes.
(D) 10.04 minutes.
(E) 10.54 minutes.

① Calc k $\ln \frac{1}{2} = -k t_{1/2}$

$-0.6931 = -k(20.39\ \text{min})$

$k = 0.03399\ \text{min}^{-1}$

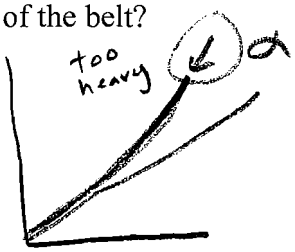
② Calc t $\ln\left[\frac{A}{A_0}\right] = -kt$

$\ln\left[\frac{0.7239}{1.000\ g}\right] = -(0.03399\ \text{min}^{-1})(t)$

$t = 9.54\ \text{min}$

16. Consider the band of stability (AKA "Belt of Stability" located near the beginning of the exam). What decay is expected for a species located in the extreme top right of the belt?

(A) Alpha decay
(B) Beta decay
(C) Gamma decay
(D) DK decay
(D) Moral decay due to the overuse of video games




17. A radioactive decay series that begins with $^{232}Th$ ends with formation of the stable nuclide $^{208}Pb$. How many alpha particle emissions and how many beta particle emissions are involved in the sequence of radioactive decays?

(A) 7 alpha and 6 beta decays
(B) 7 alpha and 4 beta decays
(C) 7 alpha and 2 beta decays
(D) 6 alpha and 2 beta decays
(E) 6 alpha and 4 beta decays

drop 24

$^{232}_{90}Th \rightarrow 6\,^{4}_{2}\alpha + 4\,^{0}_{-1}\beta + {}^{208}_{82}Pb$

90 → 90 (without β)

94

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

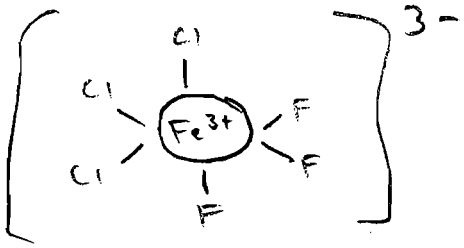
(A) An example of nuclear fusion is ${}^{1}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He$.
(B) An example of nuclear fission is ${}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{137}_{52}Te + {}^{97}_{40}Zr + 2\ {}^{1}_{0}n$.
(C) The half-life is the time required for a sample to decay to one-half its original 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.

19. Consider coordination chemistry. Which of the following is not a Lewis base?

(A) $H_2O$
(B) $F^-$
(C) $C_2O_4^{2-}$ (ox; the oxalate ion)
(D) $NH_2CH_2CH_2NH_2$ (en; ethylenediamine)
(E) $Cu^{2+}$ Lewis Acid

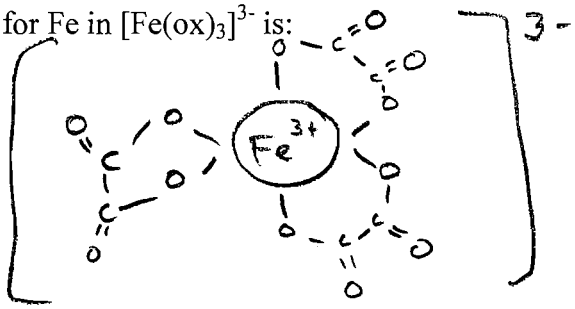
20. The coordination number for $Fe^{3+}$ in $[FeCl_3F_3]^{3-}$ is:

(A) 0.
(B) 1.
(C) 2.
(D) 3.
(E) 6.

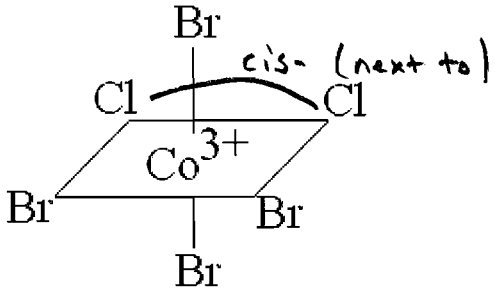



21. The coordination number for Fe in $[Fe(ox)_3]^{3-}$ is:

(A) 1.
(B) 2.
(C) 3.
(D) 4.
(E) 6.




22. The complex:




(A) is the cis- isomer and it is polar
(B) is the trans- isomer and it is polar
(C) is the mer- isomer and it is polar
(D) is the fac- isomer and it is polar
(E) is the fac- isomer and it is non-polar

23. How many d-electrons does $Cu^{2+}$ have?

11 - 2 = 9

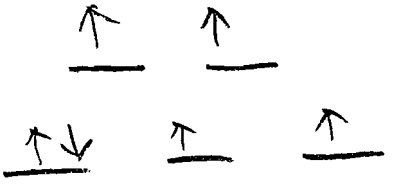
(A) 7.
(B) 8.
(C) 9.
(D) 10.
(E) 11.

$d^9$

24. How many **unpaired** electrons are present in $[Fe(NO_2)_6]^{4-}$?
[Fe is the $Fe^{2+}$ ion; $(NO_2)$ is the $NO_2^-$ ion; and the $Fe^{2+}$ is **high spin**].

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

$Fe^{2+}$ is $d^6$ (8 - 2 = 6)



25. The CH 123 Final Exam is scheduled for Wednesday, June 8, 2004, 7:30-9:20am. Rooms will be assigned and posted near the conclusion of the term.

Which one of the following statements is **FALSE**?

(A) The CH 123 Final Exam is scheduled for Wednesday, June 8 at 7:30am.
(B) The CH 123 Final Exam is scheduled for Wednesday, June 8 at 7:30am.
(C) The CH 123 Final Exam is scheduled for Wednesday, June 8 at 7:30am.
(D) The CH 123 Final Exam is scheduled for Wednesday, June 8 at 7:30am.
(E) The oxidation number of Mo in $MoO_2$ is -4.