

**Review for the General Chemistry Final Exam**  
**Second Semester Part 3 of 3 (a) Thermodynamics, (b) Transition Metals, (c) Redox and Electrochemistry, (d) Nuclear and (e) Organic**

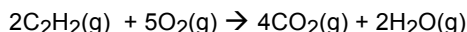
**Part 14. Thermodynamics:**

203. A 10.0 g sample of silver is heated to 100.0 °C and then added to 20.0 g of water at 23.0 °C in an insulated calorimeter. At thermal equilibrium the temperature of the system was measured as 25.0 °C. What is the specific heat of silver? [specific heat = 4.2 J g<sup>-1</sup> °C<sup>-1</sup>]

- (A) 0.11 J/g K (C) 17 J/g K  
 (B) 0.22 J/g K (D) 34 J/g K

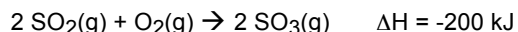
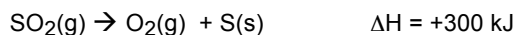
204. Given these thermodynamic values, calculate ΔH in kJ for the reaction that follows.

	ΔH <sub>f</sub> <sup>o</sup> (kJ/mol):
C <sub>2</sub> H <sub>2</sub> (g)	+227
H <sub>2</sub> O(g)	-242
CO <sub>2</sub> (g)	-393



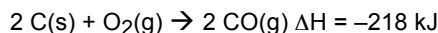
- (A) -1830 kJ (B) -2284 kJ  
 (C) -2510 kJ (D) -1605 kJ

205. Given these equations calculate the heat of formation of SO<sub>3</sub>(g).



- (A) -500 kJ mol<sup>-1</sup> (C) +100 kJ mol<sup>-1</sup>  
 (B) -400 kJ mol<sup>-1</sup> (D) +200 kJ mol<sup>-1</sup>

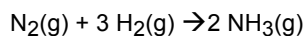
206. Given:



How much energy is produced in the combustion of 28 g of CO(g)? [Atomic Masses: C 12.0 g mol<sup>-1</sup>; O 16.0 g mol<sup>-1</sup>]

- (A) 88 kJ (B) 109 kJ  
 (C) 175 kJ (D) 284 kJ

207. Calculate ΔH (in kJ·mol<sup>-1</sup>) for the reaction



Bond Energies (kJ mol <sup>-1</sup> )	
H-H	435
N-N	946 (in N <sub>2</sub> )
N-H	389

- (A) 2340 kJ of heat absorbed  
 (B) 213 kJ of heat absorbed  
 (C) 2340 kJ of heat evolved  
 (D) 83 kJ of heat evolved

208. Which change is likely to be accompanied by the greatest increase in entropy?

- (A) N<sub>2</sub>(g) + 3 H<sub>2</sub>(g) → 2 NH<sub>3</sub>(g) (at 25 °C)  
 (B) Ag<sup>+</sup>(aq) + Cl<sup>-</sup>(aq) → AgCl(s) (at 25 °C)  
 (C) CO<sub>2</sub>(s) → CO<sub>2</sub>(g) (at -70 °C)  
 (D) H<sub>2</sub>O(g) → H<sub>2</sub>O(l) (at 100 °C)

209. For which process is the entropy change per mole the largest at constant temperature?

- (A) H<sub>2</sub>O(l) → H<sub>2</sub>O(g)  
 (B) H<sub>2</sub>O(s) → H<sub>2</sub>O(g)  
 (C) H<sub>2</sub>O(s) → H<sub>2</sub>O(l)  
 (D) H<sub>2</sub>O(l) → H<sub>2</sub>O(s)

210. In which process is entropy decreased?

- (A) dissolving sugar in water  
 (B) expanding a gas  
 (C) evaporating a liquid  
 (D) freezing water

211. When Al<sub>2</sub>O<sub>3</sub>(s) is formed from the elements at standard conditions, the values of ΔH<sup>o</sup> and ΔG<sup>o</sup> at 298 K are -1676 kJ mol<sup>-1</sup> and -1577 kJ mol<sup>-1</sup>, respectively. The standard entropy of formation per mole, in joules per degree, will be

- (A) -332 (B) -157 (C) -93.3  
 (D) -0.0933 (E) +15.7

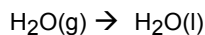
212. Vaporization of a liquid is an example of a process for which

- (A) ΔH, ΔS, and ΔG are positive at all temperatures.  
 (B) ΔH and ΔS are positive.  
 (C) ΔG is negative at low temperatures, positive at high temperatures.  
 (D) ΔH = ΔS

213. A particular chemical reaction has a negative ΔH and negative ΔS. Which statement is correct?

- (A) The reaction is spontaneous at all temperatures.  
 (B) The reaction is nonspontaneous at all temperatures.  
 (C) The reaction becomes spontaneous as temperature increases.  
 (D) The reaction becomes spontaneous as temperature decreases.

214. For this process at 25 °C:



- (A)  $\Delta H$  is negative and  $\Delta S$  is negative.  
 (B)  $\Delta H$  is negative and  $\Delta S$  is positive.  
 (C)  $\Delta H$  is positive and  $\Delta S$  is positive.  
 (D)  $\Delta H$  is positive and  $\Delta S$  is negative.

**Part 15. Electrochemistry:**

215. In every electrolytic and galvanic (voltaic) cell the anode is that electrode

- (A) at which oxidation occurs.  
 (B) which attracts cations.  
 (C) at which electrons are supplied to the solution.  
 (D) at which reduction occurs.

216. Which statement is true for the cell as it discharges?



- (A) Oxidation occurs at the tin electrode.  
 (B) Electrons will flow from the tin electrode to the zinc electrode.  
 (C) The concentration of  $\text{Zn}^{2+}$  will increase.  
 (D) The mass of the tin electrode will decrease.

217. In the electrolysis of dilute  $\text{H}_2\text{SO}_4$ , the anode reaction is

- (A) where reduction occurs.  
 (B)  $2 \text{H}^+ + 2 \text{e}^- \rightarrow \text{H}_2$   
 (C)  $4 \text{OH}^- \rightarrow \text{O}_2 + 4 \text{H}^+ + 4 \text{e}^-$   
 (D)  $2 \text{H}_2\text{O} \rightarrow 4 \text{H}^+ + \text{O}_2 + 4 \text{e}^-$ .

218. Five metals are represented by the symbols **L**, **M**, **T**, **R**, and **Z**. When a solution containing all five ions at 1 M concentration is electrolyzed with a small applied voltage, which metal is most likely to be deposited first on the cathode?

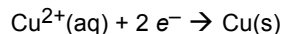
Unknown Metals		
Standard Oxidation Potentials $E^\circ$		
<b>L</b>	$\text{L}^{2+} + 2 \text{e}^-$	+0.76 V
<b>M</b>	$\text{M}^{2+} + 2 \text{e}^-$	+0.44 V
<b>T</b>	$\text{T}^{2+} + 2 \text{e}^-$	+0.13 V
<b>R</b>	$\text{R}^{3+} + 3 \text{e}^-$	-0.34 V
<b>Z</b>	$\text{Z}^+ + \text{e}^-$	-0.80 V

- (A) **L** (B) **M** (C) **T** (D) **R** (E) **Z**

219. How many coulombs of electricity are required to completely convert 0.340 g of  $\text{AgNO}_3$  into metallic Ag?

- (A) 19.3 (B) 96.5 (C) 303 (D) 386

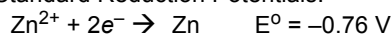
220. What time is required to plate 2.08 g of copper at a constant current flow of 1.26 A? [Atomic Mass Cu 63.5 g  $\text{mol}^{-1}$ ]



- (A) 41.8 min (C) 128 min  
 (B) 83.6 min (D) 4820 min

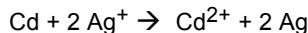
221. What would be the  $E^\circ$  value in volts for a zinc–silver galvanic cell?

Standard Reduction Potentials:

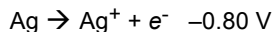
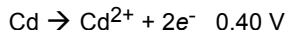


- (A) 0.76 – 0.80  
 (B) 0.76 – (2 x 0.80)  
 (C) 0.76 + 0.80  
 (D) 0.76 + (2 x 0.80)

222. What is the  $E^\circ$  value of the cell reaction described by the equation?



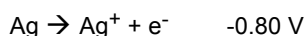
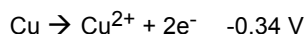
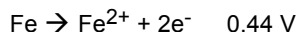
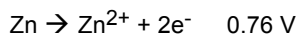
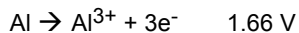
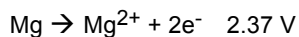
Standard Reduction Potentials  $E^\circ$



- (A) +0.40 V (B) -0.40 V  
 (C) +1.20 V (D) +2.00 V

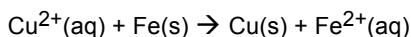
223. Using only the metals Mg, Al, Zn, Fe, Cu and Ag, together with their 1.0 M salt solutions, a voltaic cell of the highest possible voltage would be constructed using electrodes of these metals:

Standard Oxidation Potentials  $E^\circ$



- (A) Mg and Ag (D) Mg and Fe  
 (B) Zn and Cu (E) Al and Ag

224. Consider the equation



The standard potential for this reaction is 0.78 V. What is the potential if the concentrations are 0.040 M  $\text{Cu}^{2+}$ ? and 0.40 M  $\text{Fe}^{2+}$ ?

- (A) 0.72 V                      (B) 0.75 V  
(C) 0.81 V                      (D) 0.84 V

225. Which reaction is spontaneous in the direction written?

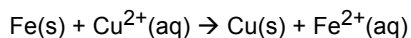
Standard Reduction Potentials $E^\circ$	
$\text{Mg} \rightarrow \text{Mg}^{2+} + 2 e^-$	2.37 V
$\text{Al} \rightarrow \text{Al}^{3+} + 3 e^-$	1.66 V
$\text{Zn} \rightarrow \text{Zn}^{2+} + 2 e^-$	0.76 V
$\text{Fe} \rightarrow \text{Fe}^{2+} + 2 e^-$	0.44 V
$\text{Cu} \rightarrow \text{Cu}^{2+} + 2 e^-$	-0.34 V
$\text{Ag} \rightarrow \text{Ag}^+ + e^-$	-0.80 V

- (A)  $2 \text{Ag} + \text{Cu}^{2+} \rightarrow \text{Cu} + 2 \text{Ag}^+$   
(B)  $\text{Fe} + \text{Zn}^{2+} \rightarrow \text{Fe}^{2+} + \text{Zn}$   
(C)  $2 \text{Al} + 3 \text{Mg}^{2+} \rightarrow 2 \text{Al}^{3+} + 3 \text{Mg}$   
(D)  $2 \text{Al} + 3 \text{Zn}^{2+} \rightarrow 2 \text{Al}^{3+} + 3 \text{Zn}$

226. In the ion  $\text{H}_2\text{P}_2\text{O}_7^{2-}$ , the oxidation number for P is

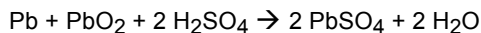
- (A) 2    (B) 4    (C) 5    (D) 6

227. Which statement is true for the reaction?



- (A)  $\text{Cu}^{2+}$  is oxidized.  
(B)  $\text{Cu}^{2+}$  gains in oxidation state.  
(C)  $\text{Cu}^{2+}$  is reduced.  
(D)  $\text{Fe}(\text{s})$  is reduced.

228. In this reaction, which substance behaves as the oxidizing agent?

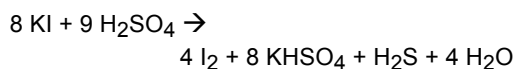


- (A) Pb                              (B)  $\text{PbSO}_4$   
(C)  $\text{PbO}_2$                         (D)  $\text{H}_2\text{SO}_4$

229. Which family of elements in the periodic table contains the most powerful oxidizing agents?

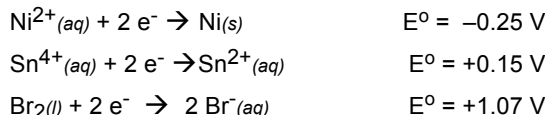
- (A) the alkali family  
(B) the nitrogen–phosphorus family  
(C) the alkaline earth family  
(D) the aluminum family  
(E) the halogen family

230. Which is true of the equation?



- (A) The reducing agent is  $\text{H}_2\text{S}$ .  
(B) The oxidizing agent is KI.  
(C) The substance reduced is  $\text{H}_2\text{SO}_4$ .  
(D) The substance oxidized is  $\text{KHSO}_4$ .  
(E) This is not an oxidation–reduction equation.

231. Standard Reduction Potentials  $E^\circ$



Which reaction will occur if each substance is in its standard state?

- (A)  $\text{Ni}^{2+}$  will oxidize  $\text{Sn}^{2+}$  to give  $\text{Sn}^{4+}$   
(B)  $\text{Sn}^{4+}$  will oxidize  $\text{Br}^-$  to give  $\text{Br}_2$   
(C)  $\text{Br}_2$  will oxidize  $\text{Ni}(\text{s})$  to give  $\text{Ni}^{2+}$   
(D)  $\text{Ni}^{2+}$  will oxidize  $\text{Br}_2$  to give  $\text{Br}^-$

232. Which metal will reduce copper(II) ions but not zinc ions?

Standard Reduction Potentials $E^\circ$	
$\text{Na} \rightarrow \text{Na}^+ + e^-$	$E^\circ = 2.71 \text{ V}$
$\text{Zn} \rightarrow \text{Zn}^{2+} + 2 e^-$	$E^\circ = 0.76 \text{ V}$
$\text{Fe} \rightarrow \text{Fe}^{2+} + 2 e^-$	$E^\circ = 0.4 \text{ V}$
$\text{Pb} \rightarrow \text{Pb}^{2+} + 2 e^-$	$E^\circ = 0.13 \text{ V}$
$\text{H}_2 \rightarrow 2\text{H}^+ + 2 e^-$	$E^\circ = 0.00 \text{ V}$
$\text{Cu} \rightarrow \text{Cu}^{2+} + 2 e^-$	$E^\circ = -0.34 \text{ V}$
$\text{Hg} \rightarrow \text{Hg}^{2+} + 2 e^-$	$E^\circ = -0.85 \text{ V}$
$\text{Ag} \rightarrow \text{Ag}^+ + e^-$	$E^\circ = -0.80 \text{ V}$

- (A) Na    (B) Hg    (C) Pb    (D) Ag

## Part 16. Coordination Chemistry:

233. Which complex ion could have *cis–trans* isomers?

- (A) square planar  $[\text{PtBrCl}_3]^{2-}$   
(B) octahedral  $[\text{Fe}(\text{CN})_6]^{3-}$   
(C) tetrahedral  $[\text{ZnBrCl}_3]^{2-}$   
(D) octahedral  $[\text{CrBr}_2(\text{NH}_3)_4]^+$

234. What geometry does  $[\text{CoF}_6]^{3-}$  exhibit?

- (A) tetrahedral    (C) square planar  
(B) octahedral    (D) trigonal bipyramidal

235. Which complex ion has the largest number of unpaired electrons?

- (A)  $\text{Cu}(\text{NH}_3)_4^{2+}$  (D)  $\text{Fe}(\text{H}_2\text{O})_6^{3+}$   
(B)  $\text{Cr}(\text{NH}_3)_6^{3+}$  (E)  $\text{CoCl}_4^{2-}$   
(C)  $\text{Mn}(\text{CN})_6^{4-}$

### Part 17. Nuclear Chemistry:

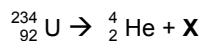
236. Which nuclear equation is properly balanced?

- (A)  ${}^4_2\text{He} + {}^9_4\text{Be} \rightarrow {}^{12}_6\text{C} + {}^1_1\text{H}$   
(B)  ${}^4_2\text{He} + {}^{14}_7\text{N} \rightarrow {}^{17}_8\text{O} + {}^1_1\text{H}$   
(C)  ${}^4_2\text{He} + {}^{24}_{12}\text{Mg} \rightarrow {}^{27}_{14}\text{Si} + {}^1_1\text{H}$   
(D)  ${}^{14}_7\text{N} + {}^0_{-1}\text{e} \rightarrow {}^{14}_8\text{O}$

237. What is the expected decay of the radioactive isotope  ${}^{39}_{17}\text{Cl}$ ?

- (A)  ${}^{39}_{17}\text{Cl} \rightarrow {}^{39}_{18}\text{Ar} + {}^0_1\text{b}$   
(B)  ${}^{39}_{17}\text{Cl} \rightarrow {}^{39}_{18}\text{Ar} + {}^0_{-1}\text{b}$   
(C)  ${}^{39}_{17}\text{Cl} \rightarrow {}^{43}_{19}\text{K} + {}^4_2\text{a}$   
(D)  ${}^{39}_{17}\text{Cl} \rightarrow {}^{39}_{18}\text{Ar}$  (with K-capture)

238. Uranium-234 undergoes spontaneous radioactive decay to give an alpha particle and a new nucleus, X.



What is X?

- (A)  ${}^{230}_{90}\text{U}$  (B)  ${}^{230}_{90}\text{Th}$   
(C)  ${}^{238}_{94}\text{U}$  (D)  ${}^{238}_{94}\text{Pu}$

239. The half-life of  ${}^{214}_{83}\text{Bi}$  is 19.7 min. Starting with  $10^{-3}$  g of  ${}^{214}_{83}\text{Bi}$ , how many grams remain after 59.1 min.?

- (A)  $1.25 \times 10^{-4}$  (C)  $3.33 \times 10^{-4}$   
(B)  $2.50 \times 10^{-4}$  (D)  $5.00 \times 10^{-4}$

240. Which particle, if lost from the **nucleus**, will result in **no** change in the atomic number?

- (A) proton (D) neutron  
(B) alpha particle (E) none of these  
(C) beta particle

### Part 18. Organic Chemistry:

241. Which hydrocarbon belongs to the series that starts with ethene?

- (A) acetylene (D) xylene  
(B) ethane (E) propene  
(C) benzene

242. Which compound is an organic acid?

- (A)  $(\text{CH}_3)_2\text{CO}$  (D)  $\text{CH}_3\text{CHO}$   
(B)  $\text{C}_{12}\text{H}_{23}\text{COOH}$  (E)  $\text{C}_5\text{H}_{12}$   
(C)  $\text{CH}_3\text{OH}$

243. Which compound is an alcohol?

- (A)  $\text{C}_3\text{H}_5(\text{OH})_3$  (D)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$   
(B)  $\text{C}_2\text{H}_5\text{CHO}$  (E)  $\text{HCOOH}$   
(C)  $\text{C}_6\text{H}_{14}$

244. An amino acid must contain the elements

- (A) C, H, O (C) C, H, N, O  
(B) C, H, N (D) C, H, O, N, S

245. Which straight-chain hydrocarbon is unsaturated?

- (A)  $\text{C}_5\text{H}_{10}$  (B)  $\text{C}_7\text{H}_{16}$   
(C)  $\text{C}_6\text{H}_{14}$  (D)  $\text{C}_2\text{H}_6$   
(E)  $\text{C}_3\text{H}_8$

246. An example of a pair of isomers is

- (A)  $\text{CH}_3\text{OCH}_3$  and  $\text{CH}_3\text{CH}_2\text{OH}$   
(B)  $\text{HOCH}_2\text{CH}_3$  and  $\text{CH}_3\text{CH}_2\text{OH}$   
(C)  $\text{CH}_3\text{OH}$  and  $\text{CH}_3\text{CH}_2\text{OH}$   
(D)  ${}^{12}_6\text{C}$  and  ${}^{14}_6\text{C}$

247. How many isomers are there for dibromobenzene?

- (A) 1 (B) 2 (C) 3 (D) 4

248. The triple bond in  $\text{C}_2\text{H}_2$  consists of

- (A) 1  $\sigma$  bond and 2  $\pi$  bonds.  
(B) 2  $\sigma$  bonds and 1  $\pi$  bond.  
(C) 3  $\sigma$  bonds.  
(D) 3  $\pi$  bonds.

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**Answers:**

203. B  
204. C  
205. B

206. D  
207. D  
208. C  
209. B  
210. D

211. A  
212. B  
213. D  
214. A  
215. A

216. C  
217. D  
218. E  
219. C  
220. B

221. C  
222. C  
223. A  
224. B  
225. D

226. C  
227. C  
228. C  
229. E  
230. C

231. C  
232. C  
233. D  
234. B  
235. D

236. B  
237. B  
238. B  
239. A  
240. D

241. E  
242. B  
243. A  
244. C  
245. A

246. A  
247. C  
248. A

Please notify Dr Mattson  
([brucemattson@creighton.edu](mailto:brucemattson@creighton.edu)) of any  
mistakes or problems with this review.