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^{-1} $°C^{-1}$]

(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.

	$\Delta H°_f$ (kJ/mol):
$C_2H_2(g)$	+227
$H_2O(g)$	-242
$CO_2(g)$	-393

$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$

(A) -1830 kJ (B) -2284 kJ

(C) -2510 kJ (D) -1605 kJ

205. Given these equations calculate the heat of formation of $SO_3(g)$.

$SO_2(g) \rightarrow O_2(g) + S(s)$ $\Delta H = +300$ kJ

$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$ $\Delta H = -200$ kJ

(A) -500 kJ mol^{-1} (C) +100 kJ mol^{-1}

(B) -400 kJ mol^{-1} (D) +200 kJ mol^{-1}

206. Given:

$2\ C(s) + O_2(g) \rightarrow 2\ CO(g)$ $\Delta H = -218$ kJ

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393$ kJ

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

(A) 88 kJ (B) 109 kJ

(C) 175 kJ (D) 284 kJ

207. Calculate ΔH (in kJ·mol^{-1}) for the reaction

$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

Bond Energies (kJ mol^{-1})	
H-H	435
N-N	946 (in N_2)
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) $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$ (at 25 °C)

(B) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ (at 25 °C)

(C) $CO_2(s) \rightarrow CO_2(g)$ (at –70 °C)

(D) $H_2O(g) \rightarrow H_2O(l)$ (at 100 °C)

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

(A) $H_2O(l) \rightarrow H_2O(g)$

(B) $H_2O(s) \rightarrow H_2O(g)$

(C) $H_2O(s) \rightarrow H_2O(l)$

(D) $H_2O(l) \rightarrow H_2O(s)$

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 $Al_2O_3(s)$ is formed from the elements at standard conditions, the values of ΔH^o and ΔG^o at 298 K are -1676 kJ mol^{-1} and -1577 kJ mol^{-1}, 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:

$$H_2O(g) \rightarrow H_2O(l)$$

(A) ΔH is negative and ΔS is negative.

(B) ΔH is negative and ΔS is positive.

(C) ΔH is positive and ΔS is positive.

(D) ΔH is positive and ΔS 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?

$$Zn \mid Zn^{2+}(1.0\ M) \parallel Sn^{2+}(1.0\ M) \mid Sn$$

(A) Oxidation occurs at the tin electrode.

(B) Electrons will flow from the tin electrode to the zinc electrode.

(C) The concentration of Zn^{2+} will increase.

(D) The mass of the tin electrode will decrease.

217. In the electrolysis of dilute H_2SO_4, the anode reaction is

(A) where reduction occurs.

(B) $2\ H^+ + 2\ e^- \rightarrow H_2$

(C) $4\ OH^- \rightarrow O_2 + 4\ H^+ + 4\ e^-$

(D) $2\ H_2O \rightarrow 4\ H^+ + O_2 + 4\ e^-$.

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^o	
L $\rightarrow$ $L^{2+} + 2\ e^-$	+0.76 V
M $\rightarrow$ $M^{2+} + 2\ e^-$	+0.44 V
T $\rightarrow$ $T^{2+} + 2\ e^-$	+0.13 V
R $\rightarrow$ $R^{3+} + 3\ e^-$	-0.34 V
Z $\rightarrow$ $Z^+ + e^-$	-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 $AgNO_3$ 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 mol^{-1}]

$$Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$$

(A) 41.8 min (C) 128 min

(B) 83.6 min (D) 4820 min

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

Standard Reduction Potentials:

$Zn^{2+} + 2e^- \rightarrow Zn$ $E^o = -0.76$ V

$Ag^+ + e^- \rightarrow Ag$ $E^o = +0.80$ V

(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^o value of the cell reaction described by the equation?

$$Cd + 2\ Ag^+ \rightarrow Cd^{2+} + 2\ Ag$$

Standard Reduction Potentials E^o

$Cd \rightarrow Cd^{2+} + 2e^-$ 0.40 V

$Ag \rightarrow Ag^+ + e^-$ –0.80 V

(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^o	
$Mg \rightarrow Mg^{2+} + 2e^-$	2.37 V
$Al \rightarrow Al^{3+} + 3e^-$	1.66 V
$Zn \rightarrow Zn^{2+} + 2e^-$	0.76 V
$Fe \rightarrow Fe^{2+} + 2e^-$	0.44 V
$Cu \rightarrow Cu^{2+} + 2e^-$	-0.34 V
$Ag \rightarrow Ag^+ + e^-$	-0.80 V

(A) Mg and Ag (D) Mg and Fe

(B) Zn and Cu (E) Al and Ag

224. Consider the equation

$Cu^{2+}(aq) + Fe(s) \rightarrow Cu(s) + Fe^{2+}(aq)$

The standard potential for this reaction is 0.78 V. What is the potential if the concentrations are 0.040 M Cu^{2+}? and 0.40 M 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^o	
$Mg \rightarrow Mg^{2+} + 2\ e^-$	2.37 V
$Al \rightarrow Al^{3+} + 3\ e^-$	1.66 V
$Zn \rightarrow Zn^{2+} + 2\ e^-$	0.76 V
$Fe \rightarrow Fe^{2+} + 2\ e^-$	0.44 V
$Cu \rightarrow Cu^{2+} + 2\ e^-$	-0.34 V
$Ag \rightarrow Ag^{+} + e^-$	-0.80 V

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

226. In the ion $H_2P_2O_7^{2-}$, the oxidation number for P is

(A) 2 (B) 4 (C) 5 (D) 6

227. Which statement is true for the reaction?

$Fe(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Fe^{2+}(aq)$

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

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

$Pb + PbO_2 + 2\ H_2SO_4 \rightarrow 2\ PbSO_4 + 2\ H_2O$

(A) Pb (B) $PbSO_4$
(C) PbO_2 (D) H_2SO_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?

$8\ KI + 9\ H_2SO_4 \rightarrow 4\ I_2 + 8\ KHSO_4 + H_2S + 4\ H_2O$

(A) The reducing agent is H_2S.
(B) The oxidizing agent is KI.
(C) The substance reduced is H_2SO_4.
(D) The substance oxidized is $KHSO_4$.
(E) This is not an oxidation–reduction equation.

231. Standard Reduction Potentials E^o

$Ni^{2+}_{(aq)} + 2\ e^- \rightarrow Ni_{(s)}$ $E^o = -0.25$ V
$Sn^{4+}_{(aq)} + 2\ e^- \rightarrow Sn^{2+}_{(aq)}$ $E^o = +0.15$ V
$Br_{2(l)} + 2\ e^- \rightarrow 2\ Br^-_{(aq)}$ $E^o = +1.07$ V

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

(A) Ni^{2+} will oxidize Sn^{2+} to give Sn^{4+}
(B) Sn^{4+} will oxidize Br^- to give Br_2
(C) Br_2 will oxidize $Ni_{(s)}$ to give Ni^{2+}
(D) Ni^{2+} will oxidize Br_2 to give Br^-

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

Standard Reduction Potentials E^o	
$Na \rightarrow Na^{+} + e^-$	$E^o = 2.71$ V
$Zn \rightarrow Zn^{2+} + 2\ e^-$	$E^o = 0.76$ V
$Fe \rightarrow Fe^{2+} + 2\ e^-$	$E^o = 0.4$ V
$Pb \rightarrow Pb^{2+} + 2\ e^-$	$E^o = 0.13$ V
$H_2 \rightarrow 2H^{+} + 2\ e^-$	$E^o = 0.00$ V
$Cu \rightarrow Cu^{2+} + 2\ e^-$	$E^o = -0.34$ V
$Hg \rightarrow Hg^{2+} + 2\ e^-$	$E^o = -0.85$ V
$Ag \rightarrow Ag^{+} + e^-$	$E^o = -0.80$ 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 $[PtBrCl_3]^{2-}$
(B) octahedral $[Fe(CN)_6]^{3-}$
(C) tetrahedral $[ZnBrCl_3]^{2-}$
(D) octahedral $[CrBr_2(NH_3)_4]^{+}$

234. What geometry does $[CoF_6]^{3-}$ exhibit?

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

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

(A) $Cu(NH_3)_4^{2+}$ (D) $Fe(H_2O)_6^{3+}$

(B) $Cr(NH_3)_6^{3+}$ (E) $CoCl_4^{2-}$

(C) $Mn(CN)_6^{4-}$

Part 17. Nuclear Chemistry:

236. Which nuclear equation is properly balanced?

(A) ${}^{4}_{2}He + {}^{9}_{4}Be \rightarrow {}^{12}_{6}C + {}^{1}_{1}H$

(B) ${}^{4}_{2}He + {}^{14}_{7}N \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$

(C) ${}^{4}_{2}He + {}^{24}_{12}Mg \rightarrow {}^{27}_{14}Si + {}^{1}_{1}H$

(D) ${}^{14}_{7}N + {}^{0}_{-1}e \rightarrow {}^{14}_{8}O$

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

(A) ${}^{39}_{17}Cl \rightarrow {}^{39}_{18}Ar + {}^{0}_{1}b$

(B) ${}^{39}_{17}Cl \rightarrow {}^{39}_{18}Ar + {}^{0}_{-1}b$

(C) ${}^{39}_{17}Cl \rightarrow {}^{43}_{19}K + {}^{4}_{2}a$

(D) ${}^{39}_{17}Cl \rightarrow {}^{39}_{18}Ar$ (with *K*-capture)

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

$${}^{234}_{92}U \rightarrow {}^{4}_{2}He + \mathbf{X}$$

What is **X**?

(A) ${}^{230}_{90}U$ (B) ${}^{230}_{90}Th$

(C) ${}^{238}_{94}U$ (D) ${}^{238}_{94}Pu$

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

(A) 1.25×10^{-4} (C) 3.33×10^{-4}

(B) 2.50×10^{-4} (D) 5.00×10^{-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) $(CH_3)_2CO$ (D) CH_3CHO

(B) $C_{12}H_{23}COOH$ (E) C_5H_{12}

(C) CH_3OH

243. Which compound is an alcohol?

(A) $C_3H_5(OH)_3$ (D) $C_2H_5OC_2H_5$

(B) C_2H_5CHO (E) HCOOH

(C) C_6H_{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) C_5H_{10} (B) C_7H_{16}

(C) C_6H_{14} (D) C_2H_6

(E) C_3H_8

246. An example of a pair of isomers is

(A) CH_3OCH_3 and CH_3CH_2OH

(B) $HOCH_2CH_3$ and CH_3CH_2OH

(C) CH_3OH and CH_3CH_2OH

(D) ${}^{12}_{6}C$ and ${}^{14}_{6}C$

247. How many isomers are there for dibromobenzene?

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

248. The triple bond in C_2H_2 consists of

(A) l σ bond and 2 π bonds.

(B) 2 σ bonds and 1 π bond.

(C) 3 σ bonds.

(D) 3 π bonds.

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) of any mistakes or problems with this review.