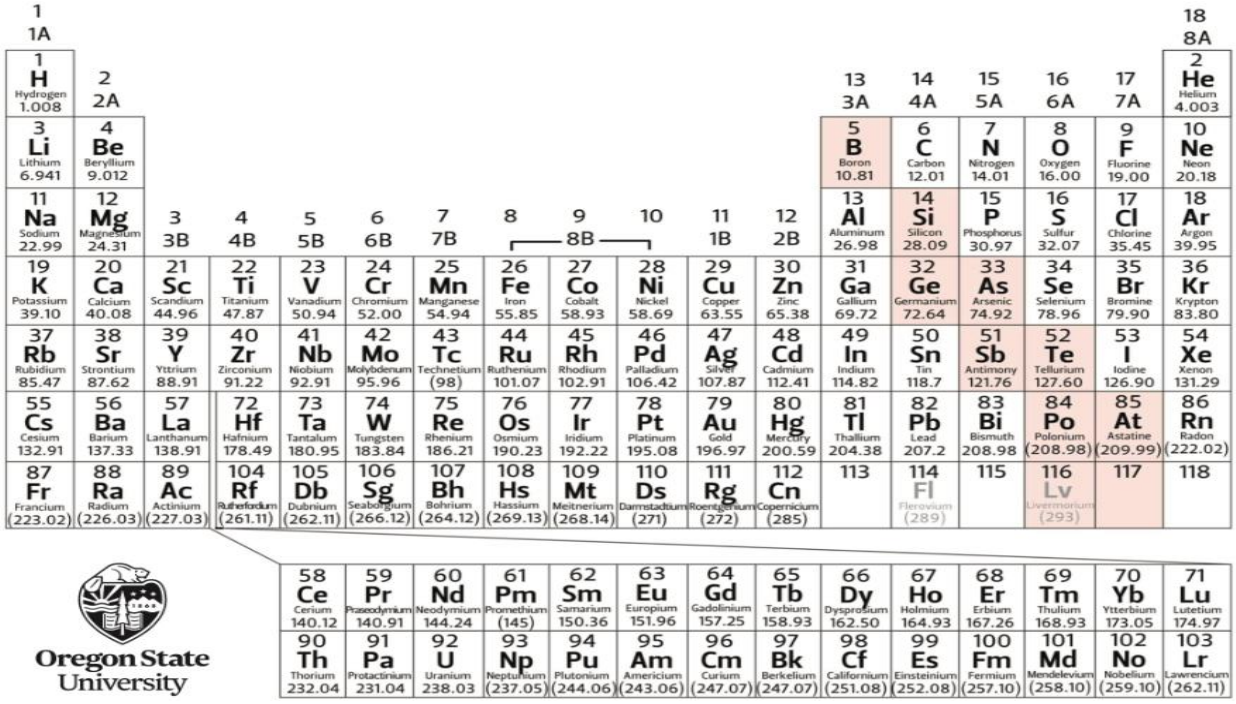
Name: _____

This is a practice test for CH 233 midterm II. There are 16 multiple choice/short answer and 6 free response questions and is representative of what could be expected on the actual midterm. Please treat it as a real examination, with no outside help from notes, internet, or peers. A lot of these questions will require you to reference the cover sheet for tabulated data. Take 80 + 20 minutes to complete this practice test and remember to keep in mind significant figures. Once done, let James know for the answer key. Good luck!



1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H Hydrogen 1.008	2 2A											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012																10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.96	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.7	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (208.98)	85 At Astatine (209.99)	86 Rn Radon (222.02)
87 Fr Francium (223.02)	88 Ra Radium (226.03)	89 Ac Actinium (227.03)	104 Rf Rutherfordium (261.11)	105 Db Dubnium (262.11)	106 Sg Seaborgium (266.12)	107 Bh Bohrium (264.12)	108 Hs Hassium (269.13)	109 Mt Meitnerium (268.14)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113	114 Fl Flerovium (289)	115	116 Lv Livermorium (293)	117	118

58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.97
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237.05)	94 Pu Plutonium (244.06)	95 Am Americium (243.06)	96 Cm Curium (247.07)	97 Bk Berkelium (247.07)	98 Cf Californium (251.08)	99 Es Einsteinium (252.08)	100 Fm Fermium (257.10)	101 Md Mendelevium (258.10)	102 No Nobelium (259.10)	103 Lr Lawrencium (262.11)

Oregon State University

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

$R = 8.314$ J/mol·K

$N_A = 6.022 \times 10^{23}$

$S = k \ln W$

$h = 6.626 \times 10^{-34}$ J·s/photon

$\Delta G°_{rxn} = -RT \ln K$

$\ln K = -\frac{\Delta H°rxn}{R}\left(\frac{1}{T}\right) + \frac{\Delta S°rxn}{R}$

$\Delta G_{rxn} = \Delta G°_{rxn} + RT \ln Q$

$c = 3.00 \times 10^8$ m/s

$E_{cell} = E°_{cell} - \frac{RT}{nF} \ln Q$

$\Delta G° = -nF\, E°_{cell}$

$\Delta G = \Delta H - T\Delta S$

$k = 1.381 \times 10^{-23}$ J/K

$K = °C + 273.15$

$E = hc/\lambda$

$t_{1/2}\ [^{14}C] = 5730$ y

Thermodynamic Properties of Hydrogen Peroxide, H_2O_2

	$H_2O_{2(l)}$	$H_2O_{2(g)}$
$\Delta H°$ (kJ/mol)	-187.7	-136.3
$\Delta G°$ (kJ/mol)	-120.4	-105.6
$\Delta S°$ (J/K mol)	109.6	232.7

Reduction Half-Reaction		$E°$(V)
$F_2(g) + 2\,e^-$	$\longrightarrow 2\,F^-(aq)$	2.87
$H_2O_2(aq) + 2\,H^+(aq) + 2\,e^-$	$\longrightarrow 2\,H_2O(l)$	1.78
$PbO_2(s) + 4\,H^+(aq) + SO_4^{2-}(aq) + 2\,e^-$	$\longrightarrow PbSO_4(s) + 2\,H_2O(l)$	1.69
$MnO_4^-(aq) + 4\,H^+(aq) + 3\,e^-$	$\longrightarrow MnO_2(s) + 2\,H_2O(l)$	1.68
$MnO_4^-(aq) + 8\,H^+(aq) + 5\,e^-$	$\longrightarrow Mn^{2+}(aq) + 4\,H_2O(l)$	1.51
$Au^{3+}(aq) + 3\,e^-$	$\longrightarrow Au(s)$	1.50
$PbO_2(s) + 4\,H^+(aq) + 2\,e^-$	$\longrightarrow Pb^{2+}(aq) + 2\,H_2O(l)$	1.46
$Cl_2(g) + 2\,e^-$	$\longrightarrow 2\,Cl^-(aq)$	1.36
$Cr_2O_7^{2-}(aq) + 14\,H^+(aq) + 6\,e^-$	$\longrightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(l)$	1.33
$O_2(g) + 4\,H^+(aq) + 4\,e^-$	$\longrightarrow 2\,H_2O(l)$	1.23
$MnO_2(s) + 4\,H^+(aq) + 2\,e^-$	$\longrightarrow Mn^{2+}(aq) + 2\,H_2O(l)$	1.21
$IO_3^-(aq) + 6\,H^+(aq) + 5\,e^-$	$\longrightarrow \frac{1}{2}I_2(aq) + 3\,H_2O(l)$	1.20
$Br_2(l) + 2\,e^-$	$\longrightarrow 2\,Br^-(aq)$	1.09
$VO_2^+(aq) + 2\,H^+(aq) + e^-$	$\longrightarrow VO^{2+}(aq) + H_2O(l)$	1.00
$NO_3^-(aq) + 4\,H^+(aq) + 3\,e^-$	$\longrightarrow NO(g) + 2\,H_2O(l)$	0.96
$ClO_2(g) + e^-$	$\longrightarrow ClO_2^-(aq)$	0.95
$Ag^+(aq) + e^-$	$\longrightarrow Ag(s)$	0.80
$Fe^{3+}(aq) + e^-$	$\longrightarrow Fe^{2+}(aq)$	0.77
$O_2(g) + 2\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2O_2(aq)$	0.70
$MnO_4^-(aq) + e^-$	$\longrightarrow MnO_4^{2-}(aq)$	0.56
$I_2(s) + 2\,e^-$	$\longrightarrow 2\,I^-(aq)$	0.54
$Cu^+(aq) + e^-$	$\longrightarrow Cu(s)$	0.52
$O_2(g) + 2\,H_2O(l) + 4\,e^-$	$\longrightarrow 4\,OH^-(aq)$	0.40
$Cu^{2+}(aq) + 2\,e^-$	$\longrightarrow Cu(s)$	0.34
$SO_4^{2-}(aq) + 4\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2SO_3(aq) + H_2O(l)$	0.20
$Cu^{2+}(aq) + e^-$	$\longrightarrow Cu^+(aq)$	0.16
$Sn^{4+}(aq) + 2\,e^-$	$\longrightarrow Sn^{2+}(aq)$	0.15
$2\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2(g)$	0
$Fe^{3+}(aq) + 3\,e^-$	$\longrightarrow Fe(s)$	−0.036
$Pb^{2+}(aq) + 2\,e^-$	$\longrightarrow Pb(s)$	−0.13
$Sn^{2+}(aq) + 2\,e^-$	$\longrightarrow Sn(s)$	−0.14
$Ni^{2+}(aq) + 2\,e^-$	$\longrightarrow Ni(s)$	−0.23
$Cd^{2+}(aq) + 2\,e^-$	$\longrightarrow Cd(s)$	−0.40
$Fe^{2+}(aq) + 2\,e^-$	$\longrightarrow Fe(s)$	−0.45
$Cr^{3+}(aq) + e^-$	$\longrightarrow Cr^{2+}(aq)$	−0.50
$Cr^{3+}(aq) + 3\,e^-$	$\longrightarrow Cr(s)$	−0.73
$Zn^{2+}(aq) + 2\,e^-$	$\longrightarrow Zn(s)$	−0.76
$2\,H_2O(l) + 2\,e^-$	$\longrightarrow H_2(g) + 2\,OH^-(aq)$	−0.83
$Mn^{2+}(aq) + 2\,e^-$	$\longrightarrow Mn(s)$	−1.18
$Al^{3+}(aq) + 3\,e^-$	$\longrightarrow Al(s)$	−1.66
$Mg^{2+}(aq) + 2\,e^-$	$\longrightarrow Mg(s)$	−2.37
$Na^+(aq) + e^-$	$\longrightarrow Na(s)$	−2.71
$Ca^{2+}(aq) + 2\,e^-$	$\longrightarrow Ca(s)$	−2.76
$Ba^{2+}(aq) + 2\,e^-$	$\longrightarrow Ba(s)$	−2.90
$K^+(aq) + e^-$	$\longrightarrow K(s)$	−2.92
$Li^+(aq) + e^-$	$\longrightarrow Li(s)$	−3.04

Multiple Choice Section (16 questions)

1)

ΔS will be positive for the reaction _____.

A) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

B) $2NO_2(g) \rightarrow N_2O_4(g)$

C) $BaF_2(s) \rightarrow Ba^{2+}(aq) + 2F^-(aq)$

D) $2Hg(l) + O_2(g) \rightarrow 2HgO(s)$

E) $CO_2(g) \rightarrow CO_2(s)$

2)

Given the thermodynamic data in the table below, calculate the equilibrium constant for the reaction:

$$2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$$

Substance	ΔH_f° (kJ/mol)	Δ° (J/mol · K)
$SO_2(g)$	−297	249
$O_2(g)$	0	205
$SO_3(g)$	−395	256

A) 1.06

B) 2.32×10^{24}

C) 3.82×10^{23}

D) 1.95

E) More data are needed.

3) For the reaction $C_2H_{6(g)} \rightarrow C_2H_{4(g)} + H_{2(g)}$

ΔH is +137 kJ/mol and ΔS is +120 J/K mol. This reaction is _____.

A) nonspontaneous at all temperatures

B) spontaneous only at high temperature

C) spontaneous at all temperatures

D) spontaneous only at low temperature

E) More info needed

4) The difference(s) between a voltaic cell and an electrolytic cell is that in an electrolytic cell _____. (select all)

A) electrons flow toward the anode

B) a nonspontaneous reaction is forced to occur

C) an electric current is produced by a chemical reaction

D) chemical energy is converted to electrical energy

E) oxidation occurs at the cathode

F) the anode is positive

G) the two electrodes are placed in different containers, connected through a salt bridge

5) Consider the following equation:

$$2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$$

The reaction above is not thermodynamically favored under standard conditions, but it becomes thermodynamically favored as the temperature decreases toward absolute zero. Which of the following is true at standard conditions?

a) ΔS and ΔH are both negative
b) ΔS and ΔH are both positive
c) ΔS is negative and ΔH is positive
d) ΔS is positive and ΔH is negative
e) It cannot be determined without knowing the exact temperature

6) Consider an electrochemical cell based on the reaction:

$$2H^{+}_{(aq)} + Sn_{(s)} \rightarrow Sn^{2+}_{(aq)} + H_{2(g)}$$

Which of the following actions would change the measured cell potential?

A) lowering the pH in the cathode compartment

B) increasing the pressure of hydrogen gas in the cathode compartment

C) increasing the [Sn2+] in the anode compartment

D) increasing the pH in the cathode compartment

E) Any of the above will change the measure cell potential.

7)

Which one of the following processes produces a decrease in the entropy of the system?

A) dissolution of solid KCl in water
B) mixing of two gases into one container
C) freezing water to form ice
D) melting ice to form water
E) boiling water to form steam

8)

In the Haber process, ammonia is synthesized from nitrogen and hydrogen:

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

ΔG° at 298 K for this reaction is –33.3 kJ/mol. The value of ΔG at 298 K for a reaction mixture that consists of 1.9 atm N_2, 1.6 atm H_2, and 0.65 atm NH_3 is _____.

A) -3.86×10^3 B) –1.8 C) –40.5 D) -7.25×10^3 E) –104.5

9) Which one of the following types of elements is most likely to be a good oxidizing agent?

A) transition elements

B) alkaline earth elements

C) lanthanides

D) alkali metals

E) halogens

9) Decide whether the systems described will be spontaneous, non-spontaneous, or not enough info.

A) $CO_{2(s)} \rightarrow CO_{2(g)}$ $\Delta H = 26$ kJ

B) $Q = 2.4 \times 10^{-5}$, $K_{eq} = 6.8 \times 10^{-6}$

C) $\Delta H < 0$, $\Delta S > 0$, $T = 298K$

10) Select all the p-type indicators:

A) arsenic doped with selenium
B) tin doped with indium
C) aluminum doped with silicon
D) tin doped with tellurium
E) Gallium doped with gallium

11) In a voltaic cell, electrons flow from the _____ to the _____.

A) salt bride, anode

B) anode, cathode

C) anode, salt bridge

D) salt bridge, cathode

E) cathode, anode

12) An electrochemical cell consists of one beaker containing 1.0 M $AgNO_{3(aq)}$ into which dips a piece of metallic silver and a second beaker containing 1.0 M $Zn(NO_3)_{2(aq)}$ into which dips a piece of metallic zinc. The beakers are connected by a salt bridge containing 1.0 M $KNO_{3(aq)}$. Which of the following statements will be true when a wire is connected between the two pieces of metal?

A) electrons will flow from the silver to the zinc

B) The cell voltage will be +0.04 V

C) There will be no cell voltage as the overall reaction is non-spontaneous

D) The silver will plate out on the zinc

E) The value of n used to find ΔG for this cell has the value 2.

13)

_____ is the oxidizing agent in the reaction below.

$$Cr_2O_7^{2-} + 6S_2O_3^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 3S_4O_6^{2-} + 7H_2O$$

A) Cr^{3+} B) H^+ C) $S_2O_3^{2-}$ D) $Cr_2O_7^{2-}$ E) $S_4O_6^{2-}$

14) When the reaction Mo (s) + $Cr_2O_7^{2-}{}_{(aq)}$ → $Cr^{2+}{}_{(aq)}$ + $Mo^{4+}{}_{(aq)}$ is balanced in acid, how many protons are consumed?

A) 4
B) 8
C) 12
D) 14
E) 40

15) With respect to electrochemistry (select all that are true)

A) Potassium is a stronger reducing agent than Na

B) Gold will dissolve in HCl and HNO_3 whereas copper only dissolves in HCl

C) H_2O_2 is a stronger oxidizing agent than O_2

D) A spontaneous reaction is possible when E^0cell > 0 and K > 1

E) For electrolysis of PbI_2, the cathode is $2I^-$

16) Determine in each situation if the following are more soluble, least soluble, or of same solubility than if in pure water.

$CaCO_3$ in HCl

AgBr in HCl

$Fe(OH)_2$ in NaOH

$Pb(SO_4)_2$ in HCl

Free Response Questions (6 question)

(some of these questions require the use of standard values in the front of the practice test)

17) Calculate the ΔG^o for the following reaction at standard conditions. Is it spontaneous?

$$3I_{2(s)} + 2Al_{(s)} \rightarrow 2Al^{3+}_{(aq)} + 6I^-_{(aq)}$$

18) The temperature at which liquid hydrogen peroxide reaches equilibrium at 1.0 atm is the normal boiling point of hydrogen peroxide. Calculate the boiling point of hydrogen peroxide. Is the boiling of peroxide at this temperature spontaneous?

19) The solubility product constant of partially soluble solid $M_3(OH)_2$ is 1.2×10^{-29} at 25 deg C. Determine $\Delta G_{rxn,}$ in kJ, at this temperature when the pH of the saturated $M_3(OH)_2$ is 8.11. In what direction does this reaction proceed?

$$Sr(s) + Mg^{2+} \rightleftharpoons Sr^{2+} + Mg(s)$$

20) Consider the reaction represented above that occurs at 25°C. All reactants and products are in their standard states. The value of the equilibrium constant, Keq, for the reaction is 4.2×10^{17} at 25°C.

(a) Predict the sign of the standard cell potential, E°, for a cell based on the reaction. Explain your prediction.

(b) Identify the oxidizing agent for the spontaneous reaction.

(c) If the reaction were carried out at 60°C instead of 25°C, how would the cell potential change? Justify your answer.

(d) How would the cell potential change if the reaction were carried out at 25°C with a 1.0-molar solution of $Mg(NO_3)_2$ and a 0.10-molar solution of $Sr(NO_3)_2$? Explain.

(e) When the cell reaction in (d) reaches equilibrium, what is the cell potential?

21) For some redox reaction at 25 deg C

$$A_{2(s)} + 2B^-_{(aq)} \leftarrow > 2A^-_{(aq)} + B_{2(aq)}$$

half-reaction: $A_{2(s)} + 2e^- \rightarrow 2A^-_{(aq)}$

half-reaction: $2B^-_{(aq)} \rightarrow B_{2(aq)} + 2e^-$

the Ecell potential is -0.26V where $[A^-] = 0.100M$, $[B^-] = 2.00$ M and $[B_2] = 0.500M$. Use calculations to determine if this reaction will proceed the forward or reverse direction.

22) Consider the unit cell for Jamesonnium alloy, which is in the shape of a dodecahedron. This alloy which has 24 W corner atoms, 2 X center atoms, 12Y face atoms, and 32 Z edge atoms. What is the formula of this alloy?