Chemistry 123
Final Exam

Spring 2009
June 8, 2009

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

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 last name, first name, middle initial, and student identification number. **Leave the test form number and class section number blank.**

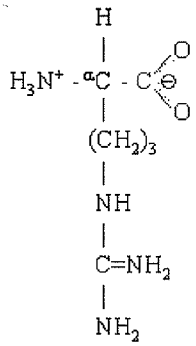
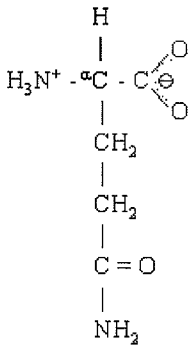
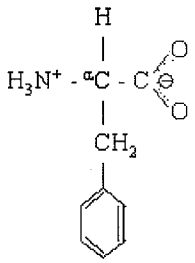
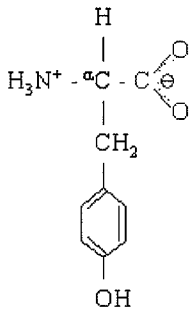
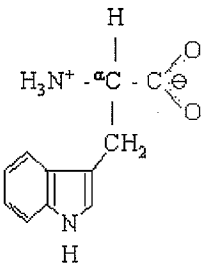
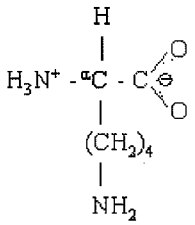
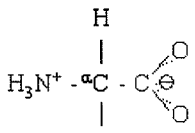
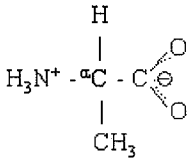
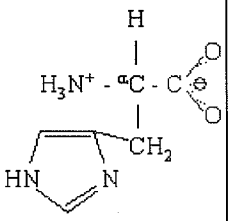
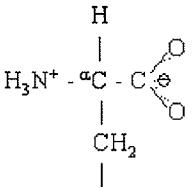
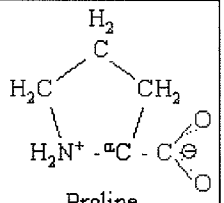
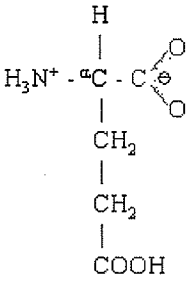
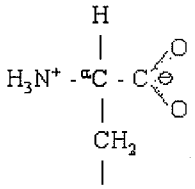
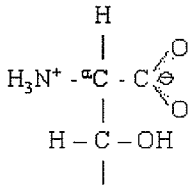
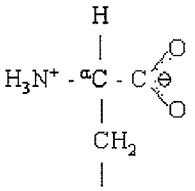
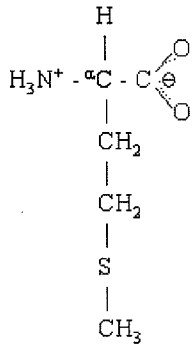
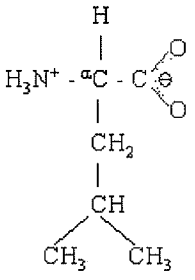
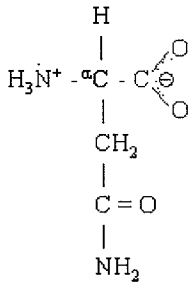
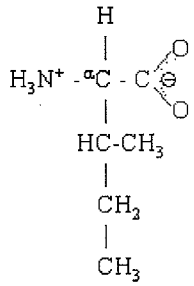
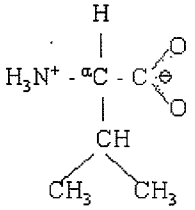
This exam consists of 36 multiple-choice questions. Each question has four points associated with it; except Question 36 which has five points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions 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.

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VII			1B	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H ydrogen 1.0079																	2 He Helium 4.0026
3 Li ithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179
11 Na odium 2.98977	12 Mg Magnesium 24.305											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K otassium 9.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.996	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.70	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb ubidium 5.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.22	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.4	47 Ag Silver 107.868	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.30
55 Cs esium 2.9054	56 Ba Barium 137.33	57–71 *Rare earths	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr ancium (223)	88 Ra Radium 226.0254	89–103 †Actinides	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (263)	107 Ns Neilsbohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ‡ (269)	111 ‡			114				

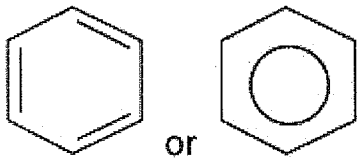
→ Stable region?

57 La Lanthanium 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9304	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.029	93 Np Neptunium 237.0482	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium 262

Reduction Half-Reaction	$E°$, 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

 Arginine (Arg / R)	 Glutamine (Gln / Q)	 Phenylalanine (Phe / F)	 Tyrosine (Tyr / Y)	 Tryptophan (Trp, W)
 Lysine (Lys / K)	 Glycine (Gly / G)	 Alanine (Ala / A)	 Histidine (His / H)	 Serine (Ser / S)
 Proline (Pro / P)	 Glutamic Acid (Glu / E)	 Aspartic Acid (Asp / D)	 Threonine (Thr / T)	 Cysteine (Cys / C)
 Methionine (Met / M)	 Leucine (Leu / L)	 Asparagine (Asn / N)	 Isoleucine (Ile / I)	 Valine (Val / V)

Selected Functional Groups:

Name	Condensed Formula	Description
alkene	$R_2C=CR_2$	contains a C=C double bond
alkyne	RC≡CR	contains a C≡C triple bond
alcohol	ROH	contains O singly bonded to a C and a H
thiol (thiol alcohol)	RSH	contains S singly bonded to a C and a H
Disulfide	SS	contains S singly bonded to an S
ether	ROR	contains O singly bonded to two C
aldehyde	RCHO	contains C doubly bonded to O and singly to H
ketone	RCOR	contains C doubly bonded to O and singly to two C
hemiacetal	ROCOHR	contains C singly bonded to O of ether and of alcohol
carboxylic acid	RCOOH	contains C doubly bonded to O and singly to O of OH
ester	RCOOR	contains C doubly bonded to O and singly to O
amine	N	contains N bonded to C and/or H
amide	RCONR	contains C doubly bonded to O and singly to N
aromatic	 or	contains a flat six-member ring

Possibly Useful Information:

$K_a[HCOOH\ (aq)] = 1.80 \times 10^{-4}$
$K_a[CH_2ClCOOH\ (aq)] = 1.40 \times 10^{-3}$
$K_a[CH_3COOH\ (aq)] = 1.80 \times 10^{-5}$
$K_a[C_9H_8O_4\ (aq)] = 3.0 \times 10^{-4}$
$K_a[NH_4^+\ (aq)] = 5.6 \times 10^{-10}$
1 Amp = 1 Coulomb/second
K_{sp} [PbF_2, lead fluoride] $= 3.6 \times 10^{-8}$

$K_a[C_6H_5COOH\ (aq)] = 6.30 \times 10^{-5}$
$K_b[NH_3\ (aq)] = 1.80 \times 10^{-5}$
$K_a[C_6H_8O_6\ (aq)] = 8.00 \times 10^{-5}$
$R = 8.314$ J/mol·K
$F = 96{,}485$ Coulombs/mole e^-
$N_A = 6.02 \times 10^{23}$
K_{sp} [MgF_2, mag fluoride] $= 3.7 \times 10^{-8}$

1. A student prepares a solution of 0.0800 M nitric acid, HNO_3 (aq). The pH is:

Strong Acid

(A) 1.10
(B) 0.0800
(C) 0.900
(D) 0.00120
(E) 1.20

$$HNO_3(aq) \xrightarrow{100\%} H^+(aq) + NO_3^-(aq)$$

0.0800 M

$$pH = -\log[H^+] = -\log(0.0800) = 1.10$$

2. A student prepares a solution of 0.670 M benzoic acid, C_6H_5COOH (aq). The $[OH^-]$ is:

Weak Acid

(A) 0.250 M
(B) 1.250 M
(C) 0.899 M
(D) 1.54×10^{-12} M
(E) 0.00650 M

	$C_6H_5COOH(aq) \rightleftarrows C_6H_5COO^-(aq) + H^+(aq)$		
I	0.670	0	0
C	$-x$	$+x$	$+x$
E	$0.670 - x$	x	x

$$K_a = 6.30 \times 10^{-5} = \frac{x^2}{0.670 - x \approx 0.670}$$

$x = [H^+] = 0.00650$ M

$pH = -\log(0.00650) = 2.19$

$pH + pOH = 14 \quad pOH = 11.8$

$$[OH^-] = 10^{-pOH} = 10^{-11.8} = 1.54 \times 10^{-12} M$$

3. A student titrates 0.5222 grams of KHP (potassium hydrogen phthalate; MW=204.2 g/mol) to the equivalence point with 24.08 mL of NaOH (aq). The concentration of the NaOH solution is:

(A) 0.09722 M
(B) 0.1722 M
(C) 0.1062 M
(D) 1.722×10^{-4} M
(E) 9.416 M

$moles_{KHP} = moles_{NaOH}$

$$\frac{g_{KHP}}{MWT_{KHP}} = M_{NaOH} V_{NaOH}$$

$$\frac{0.5222\ g}{204.2\ g/mol} = (M_{NaOH})(0.02408\ L)$$

$M_{NaOH} = 0.1062$ M

4. The pH of a buffer system which is 0.885 M C_6H_5COOH (aq) and 0.885 M C_6H_5COONa (aq) is:

(A) 0.0531
(B) 4.20
(C) 4.32
(D) 7.24
(E) 13.12

$C_6H_5COOH(aq) \rightleftarrows C_6H_5COO^-(aq) + H^+(aq)$ ← same

0.885 M 0.885 M

$K_a = 6.3\times10^{-5} = \frac{[C_6H_5COO^-][H^+]}{[C_6H_5COOH]} = \frac{(0.885\ M)[H^+]}{(0.885\ M)}$

$[H^+] = 6.3\times10^{-5}$

$pH = -\log[H^+] = -\log(6.3\times10^{-5}) = 4.20$

5. The pH of 0.200 M NH_4NO_3 (aq), is: NO_3^- spectator ion

(A) Greater than 7.00
(B) 7.00
(C) Less than 7.00

NH_4^+ acid $NH_4^+ \rightleftarrows NH_3 + H^+$

↓

pH < 7

6. Consider the reaction of ammonia (NH_3), and water. The conjugate acid is:

(A) H_2O
(B) NH_3
(C) $HCOO^-$
(D) H^+
(E) NH_4^+

$NH_3(aq) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq)$

base acid conjugate acid conjugate base

7. Which of the following processes exhibits an increase in entropy of the system?

ΔS = (+)

(A) NH_4NO_3 (aq) → NH_4NO_3 (s) ✗
(B) CH_3CH_2OH (l) → CH_3CH_2OH (s) ✗
(C) N_2O_4 (g) → 2 NO_2 (g) → 1 mol gas → 2 mol gas
(D) H_2O (g) → H_2O (s) ✗
(E) CH_3OH (g) → CH_3OH (l) ✗

The system goes to more disorder

8. The system CaO (s) + C (graphite) ↔ Ca (s) + CO (g) is allowed to reach equilibrium where q_{rev} is measured to be 303 kJ at 298 K. ΔS is:

(A) 0.984 J/K
(B) -0.984 J/K
(C) -101 J/K
(D) 101 J/K
(E) 9.84×10^5 J/K

$\Delta S = \frac{q_{rev}}{T} = \frac{303{,}000\ J}{298\ K} = 1.02 \times 10^3\ J/K$

9.

Formula	ΔH°_f (kJ/mol)	ΔG°_f (kJ/mol)	S° (J/mol•K)
C_3H_8 (g)	-103.8	-23.56	270.2
O_2 (g)	0	0	205.0
CO_2 (g)	-393.5	-394.4	213.6
H_2O (l)	-285.8	-237.2	69.91

C_3H_8 (g) + 5 O_2 (g) → 3 CO_2 (g) + 4 H_2O (l)

270.2 5 * 205.0 3 * 213.6 4 * 69.91

$\Delta S^\circ_{reaction}$ (298 K) for the combustion of propane is:

ΔS°_{rxtn} = products - reactants

(A) -374.8 J/K
(B) +393.5 J/K
(C) 0 J/K
(D) -393.5 J/K
(E) +374.8 J/K

$= \left[(3 * 213.6\ \frac{J}{mol \cdot K}) + (4 * 69.91\ J/mol \cdot K)\right] -$

$\left[(1 * 270.2\ J/mol \cdot K) + (5 * 205.0\ J/mol \cdot K)\right]$

$= -374.8\ J/K$

10. Determine ΔS for the reaction $2\ C_2H_4O\ (l) + 2\ H_2O\ (l) \rightarrow 2\ C_2H_6O\ (l) + O_2\ (g)$ using the following two reactions:

x2 (1) $2\ CO_2\ (g) + 3\ H_2O\ (l) \rightarrow C_2H_6O\ (l) + 3\ O_2\ (g)$ $\Delta S_1 = +371$ kJ

Flip x2 (2) $2\ CO_2\ (g) + 2\ H_2O\ (g) \rightarrow C_2H_4O\ (l) + 5/2 O_2\ (g)$ $\Delta S_2 = -1167$ kJ

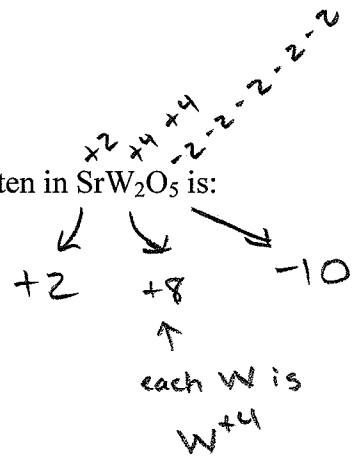
(1') $4\ CO_2 + 2\ H_2O \rightarrow 2\ C_2H_6O + 1\ O_2$ $\Delta S_1' = +742$ kJ

(2') $2\ C_2H_4O + 5\ O_2 \rightarrow 4\ CO_2 + 4\ H_2O$ $\Delta S_2' = +2334$ kJ

$2\ C_2H_4O + 2\ H_2O \rightarrow 2\ C_2H_6O + O_2$ $\Delta S = +3076$ kJ

(A) - 796 kJ
(B) + 1538 kJ
(C) - 1592 kJ
(D) + 3076 kJ
(E) - 1963 kJ

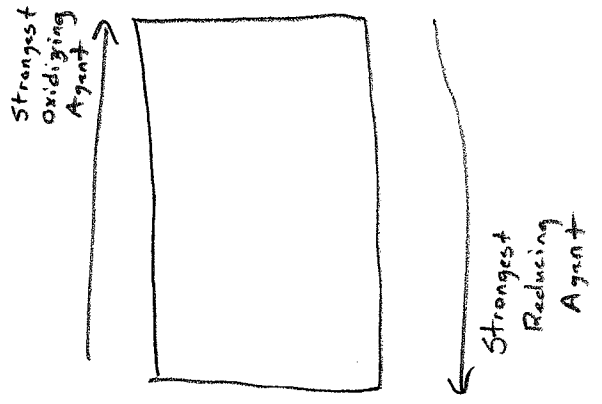
11. The oxidation number of each tungsten in SrW_2O_5 is:



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

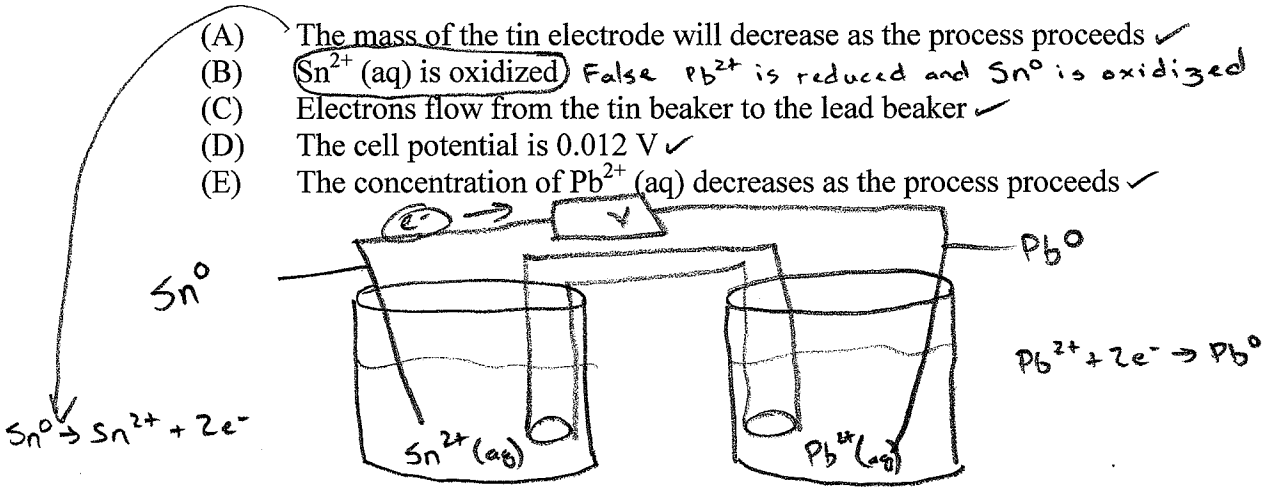
12. Consider Na^+ (aq), Pb^{+4} (aq), Zn^{+2} (aq), Ag^+ (aq), and Li^+ (aq). The strongest reducing agent is:

(A) Na^+ (aq)
(B) Pb^{+4} (aq)
(C) Zn^{+2} (aq)
(D) Ag^+ (aq)
(E) Li^+ (aq)



13. Consider a "General Chemistry Battery" in which one beaker contains aqueous tin sulfate ($SnSO_4$) and a tin metal electrode and the other beaker contains aqueous lead sulfate ($PbSO_4$) and a lead metal electrode. Which of the following statements is **false**?

(A) The mass of the tin electrode will decrease as the process proceeds ✓
(B) Sn^{2+} (aq) is oxidized False Pb^{2+} is reduced and Sn^0 is oxidized
(C) Electrons flow from the tin beaker to the lead beaker ✓
(D) The cell potential is 0.012 V ✓
(E) The concentration of Pb^{2+} (aq) decreases as the process proceeds ✓



14. A student provides a current of 5.500 amps through an aqueous solution of $AgNO_3$ for 3.000 hours. The voltage is such that silver metal is deposited at the cathode. The mass of silver deposited is:

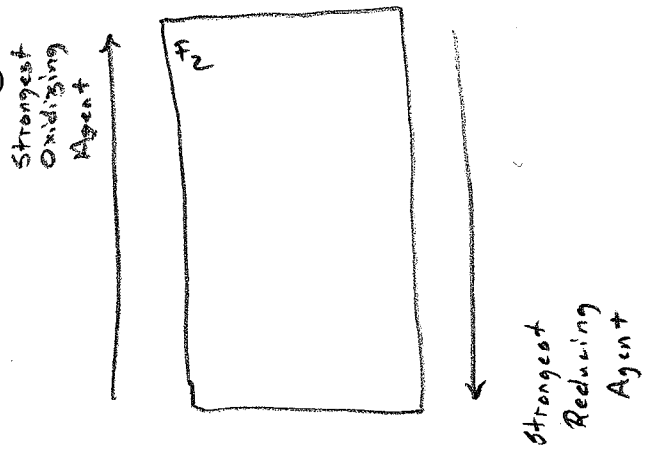
(A) 66.42 g
(B) 121.3 g
(C) 40.43 g
(D) 161.7 g
(E) 5.45 g

$$3.000\,h\left(\frac{3600\,s}{1\,h}\right)\left(\frac{5.500\,C}{s}\right)\left(\frac{1\,mol\,e^-}{96{,}485\,C}\right)\left(\frac{1\,mol\,Ag}{1\,mol\,e^-}\right)\left(\frac{107.9\,g}{1\,mol\,Ag}\right) = 66.42\,g$$

Amps ↑ F ↑

15. Consider F_2 (g), Cl_2 (g), Cu^{2+} (aq), H^+ (aq), and Li^+ (aq). The strongest oxidizing agent is:

(A) F_2 (g)
(B) Cl_2 (g)
(C) Cu^{2+} (aq)
(D) H^+ (aq)
(E) Li^+ (aq)



16. When the reaction Mn^{2+} (aq) + BiO_3^- (aq) → Bi^{3+} (aq) + MnO_4^- (aq) is correctly balanced in acid,

(A) 1 BiO_3^- (aq) is consumed
(B) 2 BiO_3^- (aq) are consumed
(C) 3 BiO_3^- (aq) are consumed
(D) 6 BiO_3^- (aq) are consumed
(E) 8 BiO_3^- (aq) are consumed

$$\left[4H_2O + Mn^{2+} \rightarrow MnO_4^- + 8H^+ + 5e^-\right] \times 2$$

(2+ → 7+)

$$\left\{2e^- + 6H^+ + BiO_3^- \rightarrow Bi^{3+} + 3H_2O\right\} \times 5$$

(5+ → 3+)

$$8H_2O + 2Mn^{2+} + 10e^- + 30H^+ + 5BiO_3^- \rightarrow 2MnO_4^- + 16H^+ + 10e^- + 5Bi^{3+} + 15H_2O$$

17. 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

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

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

$$k = 0.0340\ \frac{1}{\text{min}}$$

② Calc t

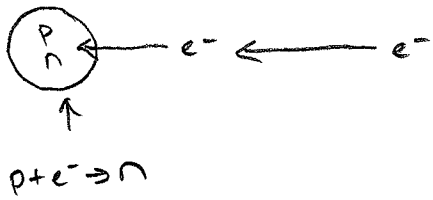
$$\ln\frac{A}{A_0} = -kt$$

$$\ln\frac{0.723\text{g}}{1.000\text{g}} = -\left(0.0340\ \frac{1}{\text{min}}\right)(t)$$

$$t = 9.54\ \text{min}$$

18. When an X-ray is generated,

(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



$p + e^- \rightarrow n$

19. A radioactive decay series that begins with No-259 ends with formation of the stable nuclide Bi-211. How many alpha particle emissions and how many beta particle emissions are involved in the sequence of radioactive decays?

(A) 7 alpha and 22 beta decays.
(B) 14 alpha and 11 beta decays.
(C) 48 alpha and 24 beta decays.
(D) 12 alpha and 11 beta decays.
(E) 12 alpha and 5 beta decays.

$^{259}_{102}No \rightarrow \underline{12}\ ^{4}_{2}\alpha + \underline{5}\ ^{0}_{-1}\beta + {}^{211}_{83}Bi$

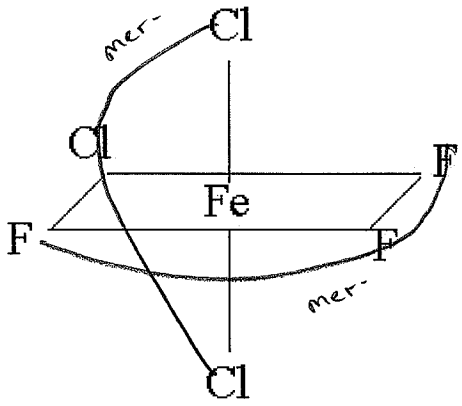
102 107

20. How many **unpaired** electrons are present in $[Fe(H_2O)_6]^{3+}$? [Fe is the Fe^{3+} ion; H_2O is water; and the Fe^{3+} is **high spin**].

Fe^{3+} is d^5

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

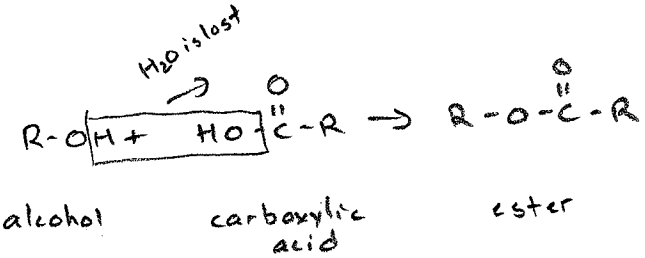
21. The complex:



(A) is cis-$[FeCl_3F_3]^{3-}$
(B) is trans-$[FeCl_3F_3]^{3-}$
(C) is mer-$[FeCl_3F_3]^{3-}$
(D) is fac-$[FeCl_3F_3]^{3-}$
(E) is Usher-$[FeCl_3F_3]^{3-}$

22. In a condensation reaction, an ester is produced from:

(A) a ketone and a carboxylic acid
(B) an alcohol and a carboxylic acid
(C) a alkene and a carboxylic acid
(D) an aldehyde and a ketone
(E) an amide and an alkene

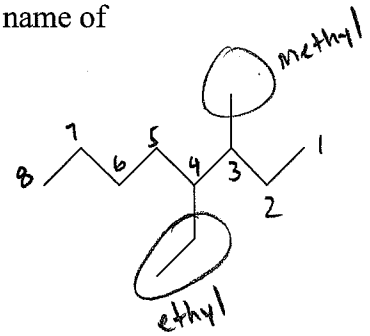


23. An organic compound with the formula $C_{100}H_{198}$ is:

(A) an alkane
(B) an amino acid
(C) an alkyne
(D) an ester
(E) an amide

$C_n H_{2n-2}$
alkyne

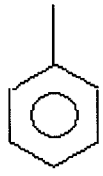
24. The systematic name of

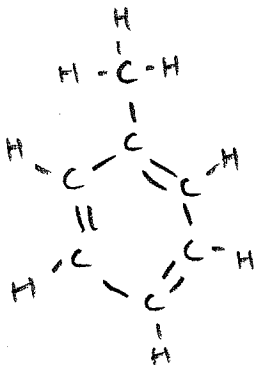


4-ethyl-3-methyl octane

(A) is 5-isopropyl-3-methyloctane
(B) is 5-isopropyl-3-methylpentane
(C) is 3-methyl-3-ethylpentane
(D) is 4-ethyl-3-methyloctane
(E) is 2,3-dimethylheptane

25. The molecular formula of

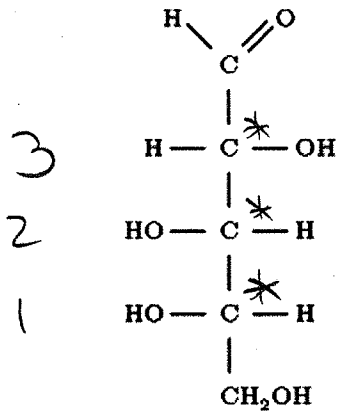




(A) is C_7H_{14}
(B) is C_6H_{14}
(C) is C_7H_9
(D) is C_7H_8
(E) is C_6H_8

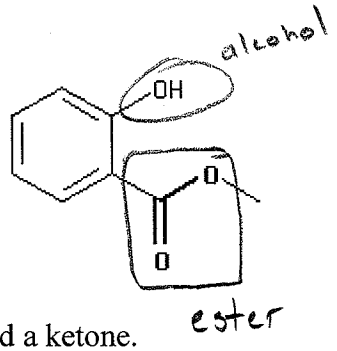
C_7H_8

26. A structure of arabinose is shown below. The arabinose shown has:



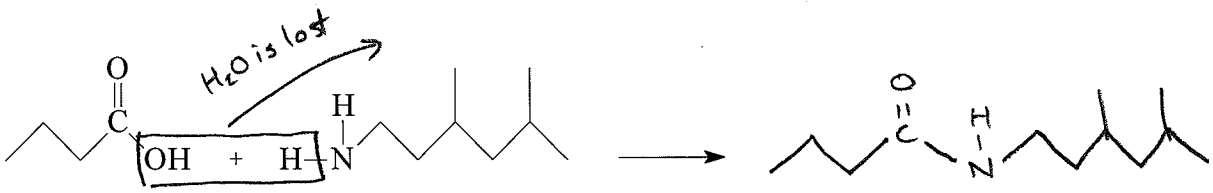
(A) one chiral carbon
(B) two chiral carbons
(C) three chiral carbons
(D) four chiral carbons
(E) five chiral carbons

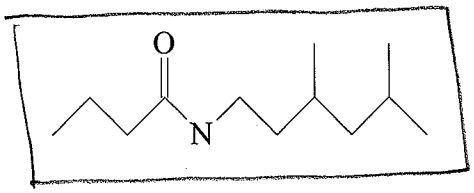
27. Methyl salicylate (the compound that smells like wintergreen) contains:

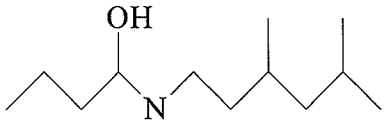


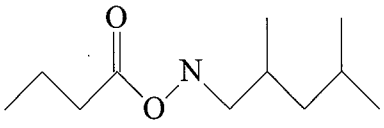
(A) an alcohol and a ketone.
(B) an alcohol and an ether.
(C) an alcohol and an ester.
(D) an alcohol and an amide.
(E) an alcohol and an aldehyde.

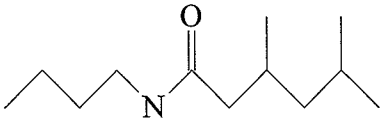
28. Complete the following condensation reaction:



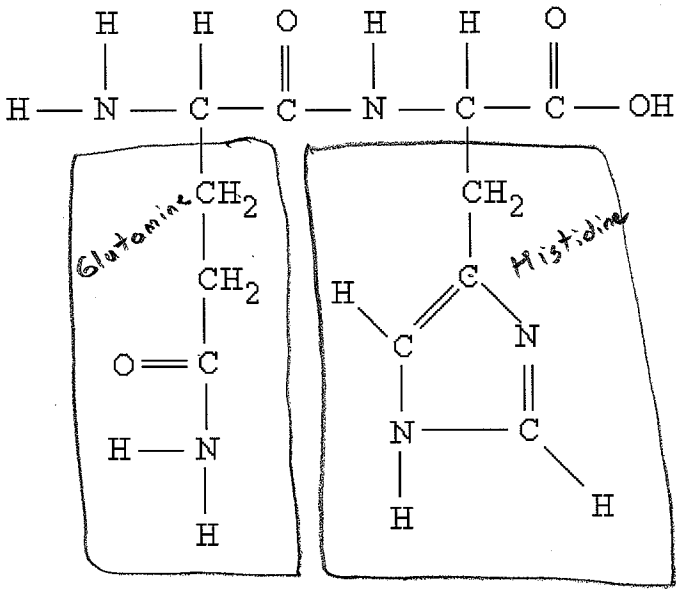
(A) 

(B) 

(C) 

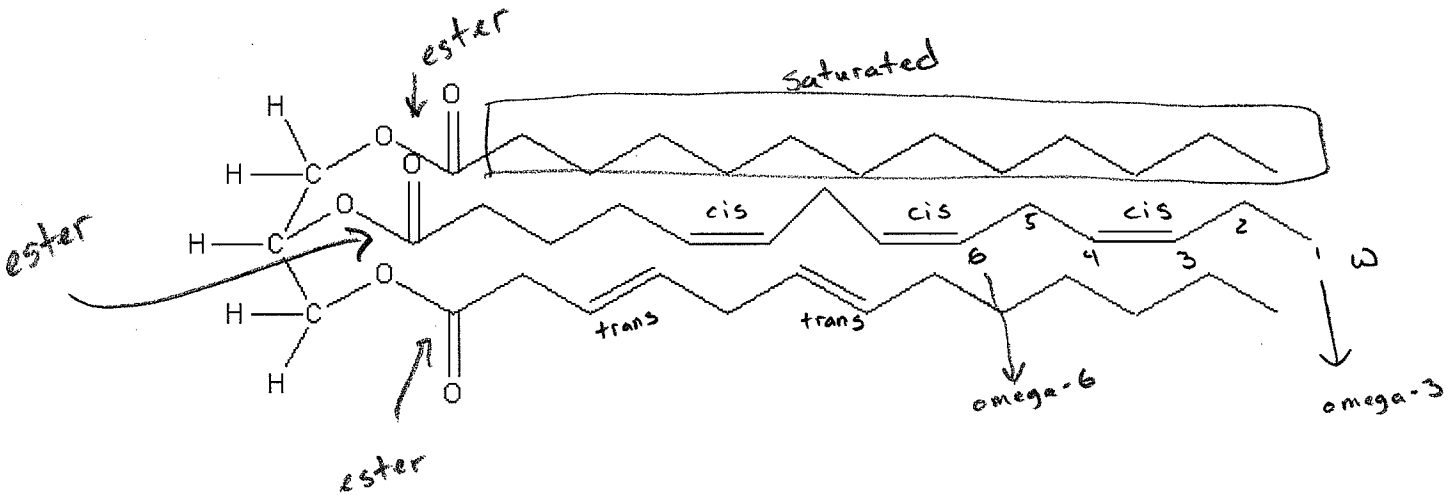
(D) 

29. Carnosine is highly concentrated in muscle and brain tissues. Carnosine is a dipeptide of which two amino acids?



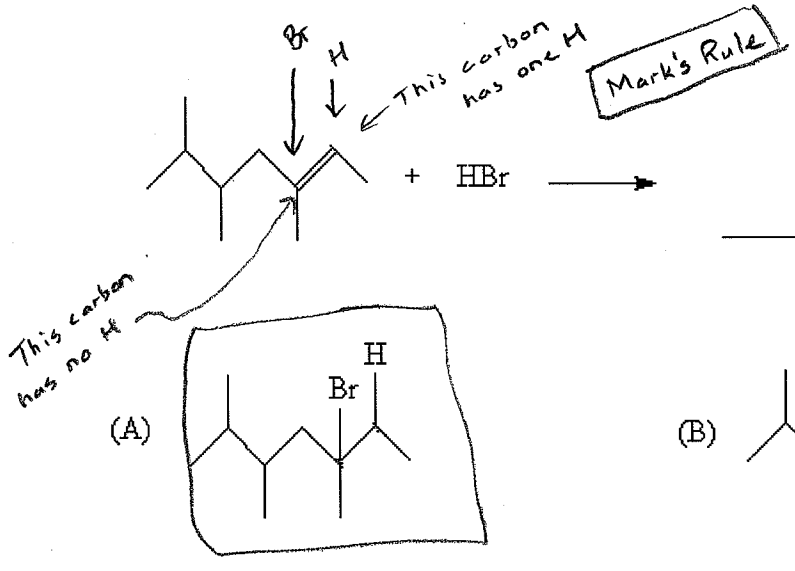
(A) proline and glutamic acid
(B) alanine and glycine
(C) glutamine and tyrosine
(D) histidine and tyrosine
(E) glutamine and histidine

30. Consider the fat molecule below. Which of the following is **false**?

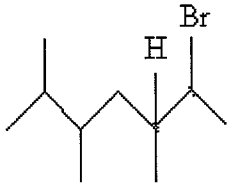


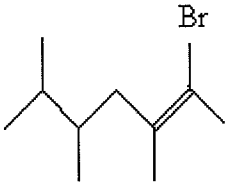
(A) This fat is an omega-6 fat ✓
(B) This fat contains 3 cis- and 2 trans- bonds ✓
(C) This fat is an omega-3 fat ✓
(D) This fat contains three ether groups → This fat contains 3 ester groups
(E) One carbon chain is saturated ✓

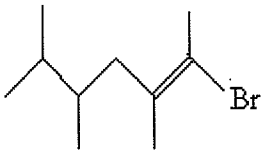
31. Complete the following addition reaction:

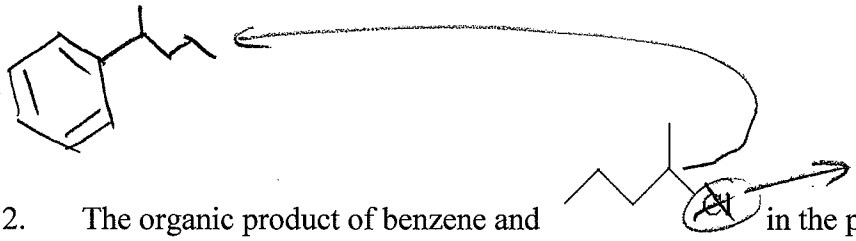


(A)

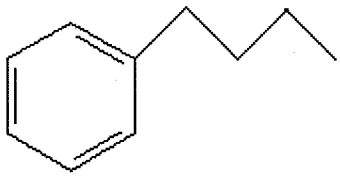
(B) 

(C) 

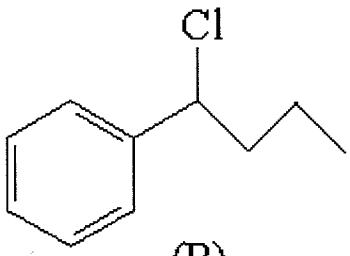
(D) 



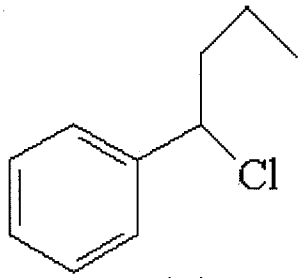
32. The organic product of benzene and in the presence of $AlCl_3$ is:



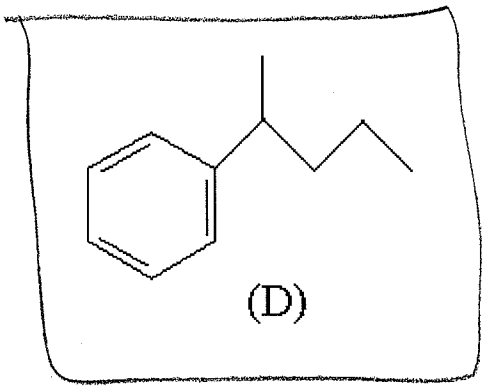
(A)



(B)



(C)



(D)

33. Well, well, well... CH 123 is over. Time to...

(A) head home, work a summer job, and try to forget about chiral carbons.

(B) cry; possibly for hours.

(C) two words: Blackberry and Skittles

(D) refurnish my room to resemble Gilbert 124. I plan on reliving general chemistry every day of my life; for it has been a breathtaking experience I cannot live without.

(E) cut my toe nails.

[Any response will receive full credit; even no response.]
Questions 1 through 32 have four points attached (128 total). Any response to Question 33 will receive full credit (2 Points total); even no response. The point total for this exam is 130 points. See the grade sheet for grade computation details. Final exam keys, scores, and course grades will be posted on the CH 123 website as they become available. Have a great life. Go out there and do some really cool stuff :)