

**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.

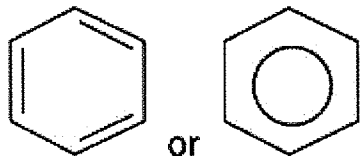
IA																	vIIIA			
1 H Hydrogen 1.0079											2 He Helium 4.0026									
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179			
11 Na Sodium 22.98977	12 Mg Magnesium 24.305											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			
		IIIB	IVB	VB	VIB	VIIB	VII					IB	IIB	IIIA	IVA	VA	VIA	VIIA		
19 K Potassium 39.0983	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 Rubidium 85.4678	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 Cesium 132.9054	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 Francium (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 †	111 †			114							
														→ Stable region?						

57 La Lanthanum 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

$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ (\text{CH}_2)_3 \\ \\ \text{NH} \\ \\ \text{C}=\text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Arginine (Arg / R)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{NH}_2 \end{array}$ <p>Glutamine (Gln / Q)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_5 \end{array}$ <p>Phenylalanine (Phe / F)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_4 \\ \\ \text{OH} \end{array}$ <p>Tyrosine (Tyr / Y)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{C}_8\text{H}_6\text{N} \end{array}$ <p>Tryptophan (Trp, W)</p>
$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ (\text{CH}_2)_4 \\ \\ \text{NH}_2 \end{array}$ <p>Lysine (Lys / K)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{H} \end{array}$ <p>Glycine (Gly / G)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_3 \end{array}$ <p>Alanine (Ala / A)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{C}_3\text{H}_3\text{N}_2 \end{array}$ <p>Histidine (His / H)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{OH} \end{array}$ <p>Serine (Ser / S)</p>
$\begin{array}{c} \text{H}_2 \\ \\ \text{C} \\ / \quad \backslash \\ \text{H}_2\text{C} \quad \text{CH}_2 \\ \backslash \quad / \\ \text{H}_2\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \end{array}$ <p>Proline (Pro / P)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COOH} \end{array}$ <p>Glutamic Acid (Glu / E)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{COOH} \end{array}$ <p>Aspartic Acid (Asp / D)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_3 \end{array}$ <p>Threonine (Thr / T)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{SH} \end{array}$ <p>Cysteine (Cys / C)</p>
$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{S} \\ \\ \text{CH}_3 \end{array}$ <p>Methionine (Met / M)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{CH} \\ / \quad \backslash \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ <p>Leucine (Leu / L)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{NH}_2 \end{array}$ <p>Asparagine (Asn / N)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{HC} - \text{CH}_3 \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$ <p>Isoleucine (Ile / I)</p>	$\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{C} \begin{array}{l} \diagup \text{O} \\ \diagdown \text{O} \end{array} \\ \\ \text{CH} \\ / \quad \backslash \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ <p>Valine (Val / V)</p>

Selected Functional Groups:

Name	Condensed Formula	Description
alkene	$R_2C=CR_2$	contains a C=C double bond
alkyne	$RC\equiv CR$	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		contains a flat six-member ring

Possibly Useful Information:

$$K_a[\text{HCOOH (aq)}] = 1.80 \times 10^{-4}$$

$$K_a[\text{CH}_2\text{ClCOOH (aq)}] = 1.40 \times 10^{-3}$$

$$K_a[\text{CH}_3\text{COOH (aq)}] = 1.80 \times 10^{-5}$$

$$K_a[\text{C}_9\text{H}_8\text{O}_4 \text{ (aq)}] = 3.0 \times 10^{-4}$$

$$K_a[\text{NH}_4^+ \text{ (aq)}] = 5.6 \times 10^{-10}$$

1 Amp = 1 Coulomb/second

$$K_{sp} [\text{PbF}_2, \text{ lead fluoride}] = 3.6 \times 10^{-8}$$

$$K_a[\text{C}_6\text{H}_5\text{COOH (aq)}] = 6.30 \times 10^{-5}$$

$$K_b[\text{NH}_3 \text{ (aq)}] = 1.80 \times 10^{-5}$$

$$K_a[\text{C}_6\text{H}_8\text{O}_6 \text{ (aq)}] = 8.00 \times 10^{-5}$$

$$R = 8.314 \text{ J/mol} \cdot \text{K}$$

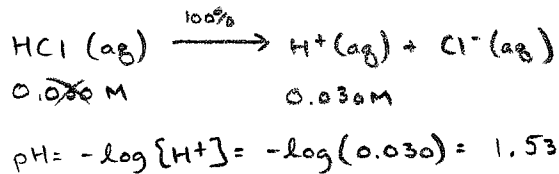
$$F = 96,485 \text{ Coulombs/mole } e^-$$

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

$$K_{sp} [\text{MgF}_2, \text{ mag fluoride}] = 3.7 \times 10^{-8}$$

1. The pH of 0.030 M HCl (aq) is:

- (A) 0.030
- (B) 0.130
- (C) 1.30
- (D) 1.53
- (E) 13.97



2. The pH of 0.305 M aqueous aniline ($\text{C}_6\text{H}_5\text{NH}_2$), $K_b = 4.2 \times 10^{-10}$, is:

- (A) 1.13
- (B) 1.13×10^{-5}
- (C) 4.95
- (D) 8.84
- (E) 9.05

	$\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$	\rightleftharpoons	$\text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$
I	0.305		0
C	-x		+x
E	0.305 - x		x

$$K_b = \frac{\text{products}}{\text{reactants}} = \frac{[\text{C}_6\text{H}_5\text{NH}_3^+][\text{OH}^-]}{[\text{C}_6\text{H}_5\text{NH}_2]} = \frac{x^2}{0.305 - x} \xrightarrow{\text{out}} = \frac{x^2}{0.305}$$

$$4.2 \times 10^{-10} = \frac{x^2}{0.305}$$

$$x = [\text{OH}^-] = 1.13 \times 10^{-5}$$

$$\text{pOH} = -\log[\text{OH}^-] = -\log(1.13 \times 10^{-5}) = 4.95$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{pH} = 14 - \text{pOH} = 14 - 4.95 = 9.05$$

3. A student titrates 0.6769 grams of an unknown acid to the equivalence point with 23.70 mL of 0.1034 M NaOH (aq). The molecular mass of the unknown acid is:

- (A) 276.2 g/mol
- (B) 286.2 g/mol
- (C) 0.003494 g/mol
- (D) 2.862 g/mol
- (E) 264.6 g/mol

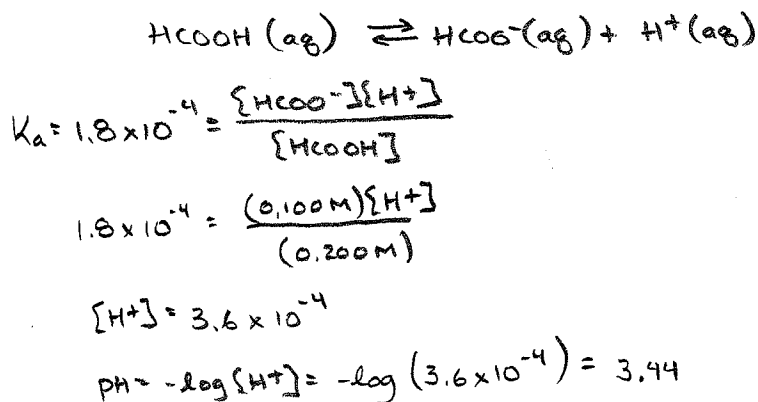
$$\text{Moles}_{\text{Acid}} = \text{Moles}_{\text{Base}}$$

$$\frac{0.6769 \text{ g}}{\text{MWT}_{\text{Acid}}} = (0.02370 \text{ L})(0.1034 \text{ M})$$

$$\text{MWT}_{\text{Acid}} = 276.2 \text{ g/mol}$$

4. The pH of a buffer system which is 0.200 M HCOOH (aq) and 0.100 M HCOONa (aq) is:

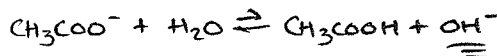
- (A) 3.44
- (B) 4.05
- (C) 3.78
- (D) 1.87
- (E) 2.22



CH₃COO⁻ base

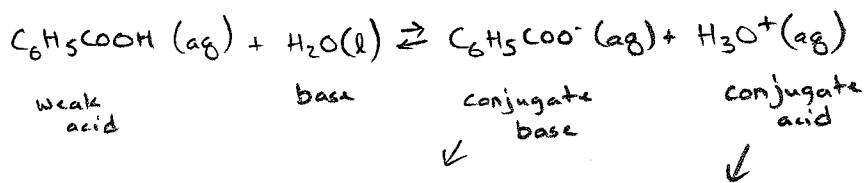
5. The pH of 0.200 M CH₃COONa (aq), is: → Na⁺ spectator ion

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



6. Consider the reaction of benzoic acid, C₆H₅COOH (aq), and water. The conjugate base is:

- (A) H₂O (l)
- (B) OH⁻ (aq)
- (C) H₃O⁺ (aq)
- (D) C₆H₅COOH (aq)
- (E) C₆H₅COO⁻ (aq)



C₆H₅COO⁻ (aq) behaves like a base - accepts a proton

H₃O⁺ (aq) behaves like an acid - donates a proton

goes to greater disorder

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

- (A) $2 \text{C}_2\text{H}_2(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$
- (B) $\text{CH}_3\text{OH}(\text{l}) \rightarrow \text{CH}_3\text{OH}(\text{s})$
- (C) $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{s})$
- (D) $\text{CH}_3\text{OH}(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$
- (E) $\text{N}_2\text{O}_4(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$

1 mol gas \rightarrow 2 mol gas

8. $\Delta H = -34 \text{ kJ}$ and $\Delta S = -845 \text{ J/K}$ for a process. Determine the temperature in which the system is at equilibrium? $\Delta G = 0$

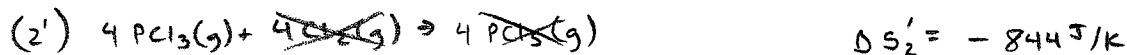
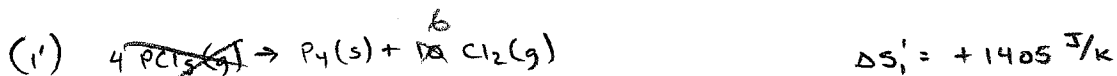
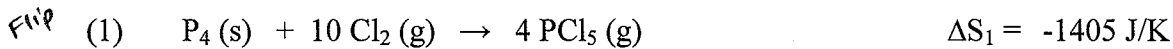
- (A) 287 K
- (B) 28.7 K
- (C) 24.9 K
- (D) 0.0249 K
- (E) 40.2 K

$$\Delta G = 0 = \Delta H - T\Delta S$$

$$0 = (-34 \text{ kJ}) - (T)(0.845 \frac{\text{kJ}}{\text{K}})$$

$$T = 40.2 \text{ K}$$

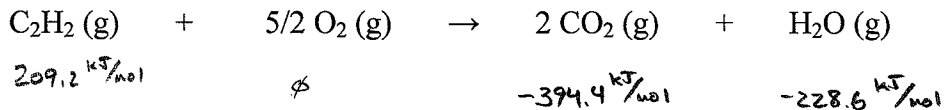
9. Determine ΔS for the reaction $4 \text{PCl}_3(\text{g}) \rightarrow \text{P}_4(\text{s}) + 6 \text{Cl}_2(\text{g})$ using the following two reactions:



- (A) +1249 J/K
- (B) -1249 J/K
- (C) +561 J/K
- (D) +776 J/K
- (E) +804 J/K

10.

Formula	ΔH_f° (kJ/mol)	ΔG_f° (kJ/mol)	S° (J/mol·K)
C_2H_2 (g)	226.7	209.2	200.9
O_2 (g)	0	0	205.1
CO_2 (g)	-393.5	-394.4	213.6
H_2O (g)	-241.8	-228.6	188.8



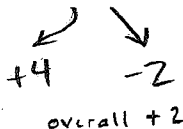
$\Delta G^\circ_{\text{reaction}}$ for the combustion of acetylene, C_2H_2 , is:

- (A) -832.2 kJ and the reaction is spontaneous at 298 K
 (B) +832.2 kJ and the reaction is not spontaneous at 298 K
 (C) -413.8 kJ and the reaction is spontaneous at 298 K
 (D) +413.8 kJ and the reaction is not spontaneous at 298 K
 (E) -1226.6 kJ and the reaction is spontaneous at 298 K

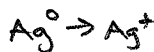
$$\Delta G^\circ_{\text{rxn}} = \text{products} - \text{reactants} = \left\{ (2 \text{ mol } CO_2)(-394.4 \text{ kJ/mol}) + (1 \text{ mol } H_2O)(-228.6 \text{ kJ/mol}) \right\} - \left\{ (1 \text{ mol } C_2H_2)(+209.2 \text{ kJ/mol}) + \left(\frac{5}{2} \text{ mol } O_2\right)(\emptyset \text{ kJ/mol}) \right\} = -1226.6 \text{ kJ}$$

11. The oxidation number vanadium in VO^{2+} is:

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

12. Consider the reaction $Cl_2(g) + 2 Ag(s) \rightarrow 2 Cl^-(aq) + 2 Ag^+(aq)$. The species being oxidized is:

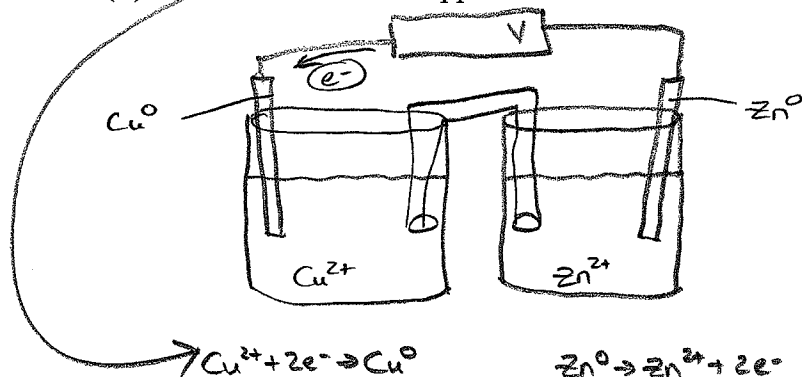
- (A) $Cl_2(g)$
 (B) $Ag(s)$
 (C) $Cl^-(aq)$
 (D) $Ag^+(aq)$



↓
losing e^-

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



14. A student provides a current of 8.0 amps through a solution of $\text{Co}^{2+}(\text{aq})$ for 6.00 hours. The voltage is such that cobalt metal is deposited at the cathode. The mass of cobalt deposited is:

- (A) 12.2 g
- (B) 24.4 g
- (C) 62.1 g
- (D) 52.8 g
- (E) 78.4 g

$$6.00 \text{ h} \left(\frac{3600 \text{ s}}{1 \text{ h}} \right) \left(\frac{8.0 \text{ C}}{1 \text{ s}} \right) \left(\frac{1 \text{ mol } e^-}{96,485 \text{ C}} \right) \left(\frac{1 \text{ mol Co}}{2 \text{ mol } e^-} \right) \left(\frac{58.93 \text{ g}}{1 \text{ mol Co}} \right) = 52.8 \text{ g Co}$$

\uparrow amps \uparrow F

$$\text{Co}^{2+} + 2e^- \rightarrow \text{Co}^0$$

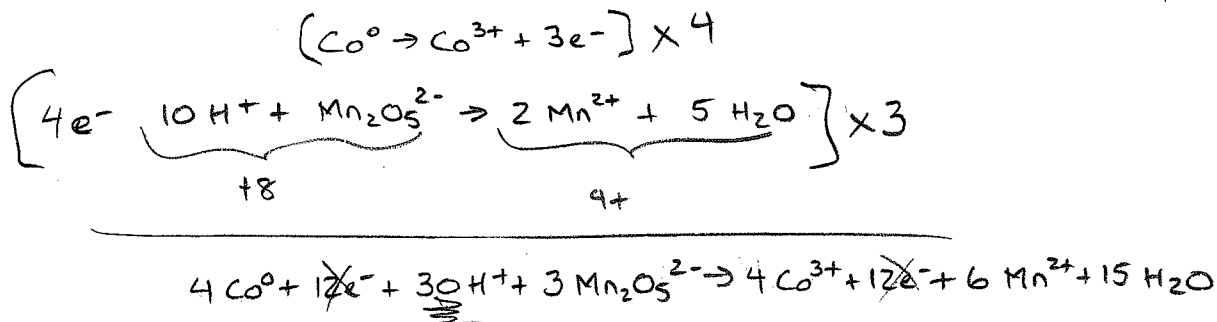
15. The calculated cell potential for the $\text{Sn}(\text{s}) + \text{Br}_2(\text{l}) \rightarrow 2 \text{Br}^-(\text{aq}) + \text{Sn}^{2+}(\text{aq})$ cell is:

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

$\text{Br}_2(\text{l}) + 2e^- \rightarrow 2\text{Br}^-(\text{aq})$	$+1.065$	}	difference
$\text{Sn}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Sn}^0(\text{s})$	-0.137		
$+1.202 \text{ V}$			

16. When the reaction $\text{Co (s)} + \text{Mn}_2\text{O}_5^{2-} (\text{aq}) \rightarrow \text{Mn}^{2+} (\text{aq}) + \text{Co}^{3+} (\text{aq})$ is correctly balanced in acid,

- (A) 3 protons (H^+) are consumed.
- (B) 10 protons (H^+) are consumed.
- (C) 20 protons (H^+) are consumed.
- (D) 30 protons (H^+) are consumed.
- (E) 42 protons (H^+) are consumed.



17. A student obtains a sample of ^{59}Fe ($t_{1/2} = 44.5$ days) containing 0.505 g. How many grams of ^{59}Fe will remain after 365 days?

- (A) 583 g
- (B) 6.37 g
- (C) 0.00210 g
- (D) 0.00172 g
- (E) 0.00154 g

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

$$-0.6931 = -(k)(44.5\text{d})$$

$$k = 0.0156 \frac{1}{\text{d}}$$

② Calc A

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

$$e^{\left[\ln \frac{A}{0.505\text{g}} \right]} = e^{\left[-(0.0156 \frac{1}{\text{d}})(365\text{d}) \right]}$$

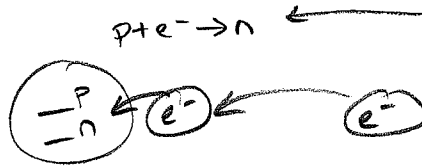
$$\frac{A}{0.505\text{g}} = e^{-5.685}$$

$$\frac{A}{0.505\text{g}} = 0.0034$$

$$A = 0.00172\text{g}$$

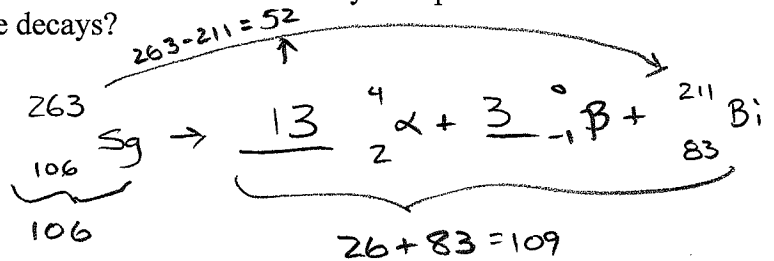
18. Consider X-Rays produced by electron capture. Which of the following is **false**?

- (A) An electron is captured by the nucleus True
- (B) The number of protons in the nucleus increases by one False p decreases by one
- (C) An x-ray is produced True
- (D) An electron falls from a higher energy orbital to a hole in the 1s orbital True
- (E) $p + e^- \rightarrow n$ True



19. A radioactive decay series that begins with Sg-263 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?

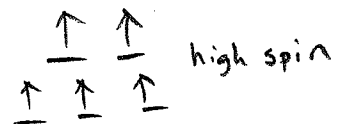
- (A) 11 alpha and 8 beta decays
- (B) 12 alpha and 12 beta decays
- (C) 12 alpha and 6 beta decays
- (D) 6 alpha and 6 beta decays
- (E) 13 alpha and 3 beta decays



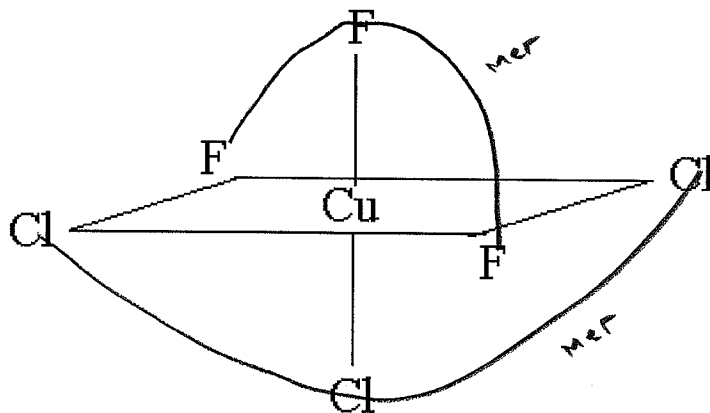
20. How many **unpaired** electrons are present in $[\text{Mn}(\text{NH}_3)_6]^{2+}$?
 [Mn is the Mn^{2+} ion; NH_3 is ammonia; and the Mn^{2+} is **high spin**].

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

Mn^{2+} is Group $7 - 2 = d^5$

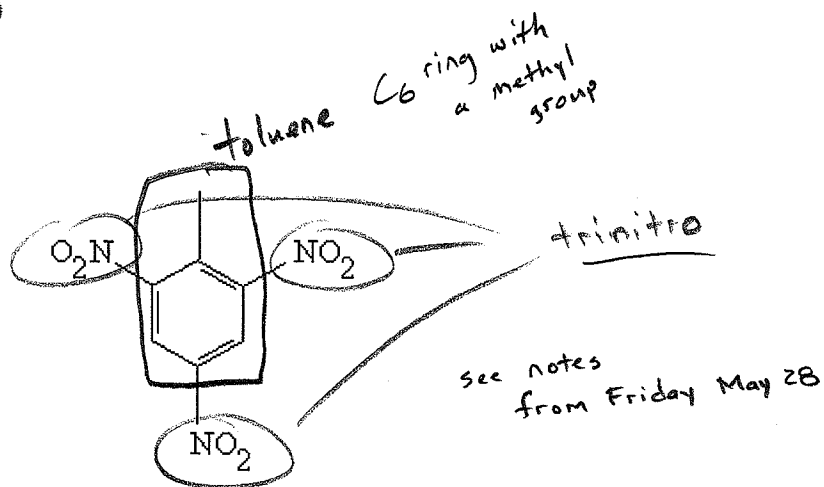


21. The complex:



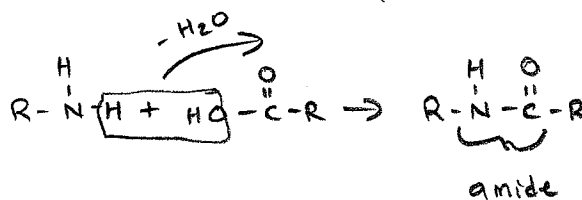
- (A) is $\text{cis-}[\text{CuCl}_3\text{F}_3]^{4-}$
- (B) is $\text{trans-}[\text{CuCl}_3\text{F}_3]^{4-}$
- (C) is $\text{fac-}[\text{CuCl}_3\text{F}_3]^{4-}$
- (D) is $\text{mer-}[\text{CuCl}_3\text{F}_3]^{4-}$
- (E) is $\text{iso-}[\text{CuCl}_3\text{F}_3]^{4-}$

22. A compound below is:



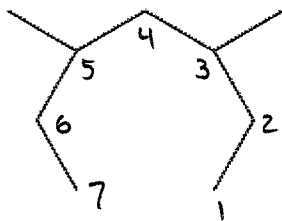
- (A) cis-trinitratehexane
- (B) trans-trinitratehexane
- (C) a cyclic alkane
- (D) a cyclic alkyne
- (E) TNT

23. When an amine and a carboxylic acid react in a condensation reaction (such as two amino acids reacting):



- (A) an ester is formed
- (B) an alkane is formed
- (C) an alkene is formed
- (D) an amide is formed
- (E) an alcohol is formed

24. The systematic name of

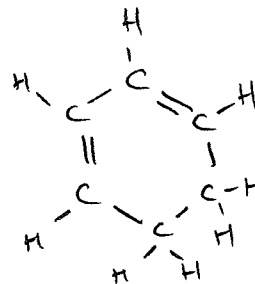
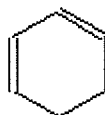


7 carbon chain is heptane

- (A) 2,2 diethylpentane
- (B) 2-ethyl-4-methylhexane
- (C) 3,5-dimethylheptane
- (D) 3,5-dimethylnonane
- (E) 3,5-dimethylcycloheptane

3,5-dimethylheptane
7C

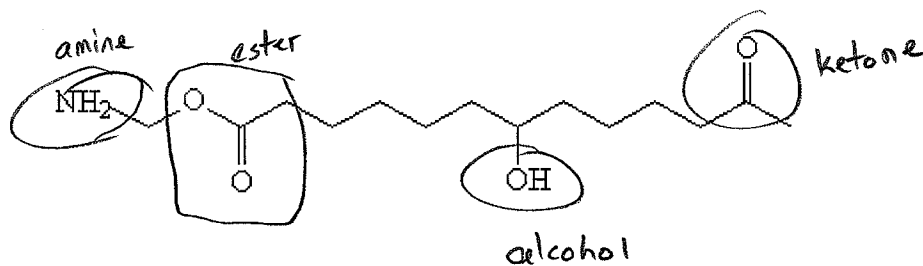
25. The molecular formula of



- (A) is C_4H_{10}
- (B) is C_6H_{14}
- (C) is C_6H_{12}
- (D) is C_6H_{10}
- (E) is C_6H_8

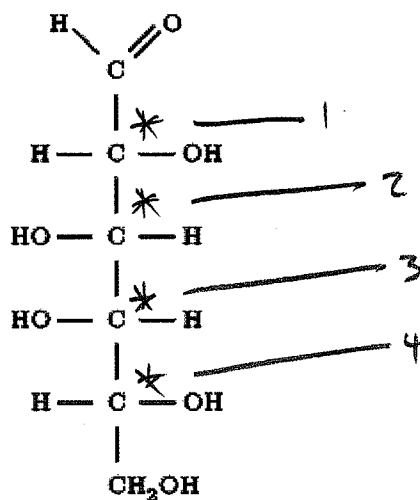
C_6H_8

26. Identify the functional groups in the following molecule:



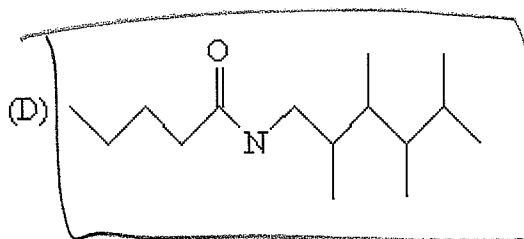
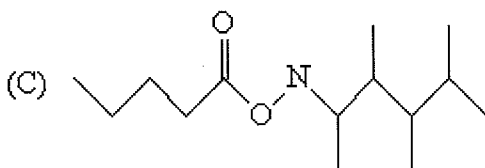
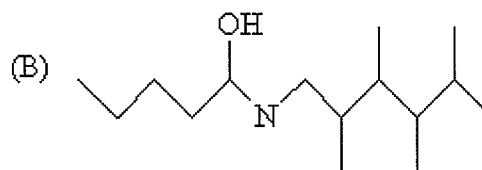
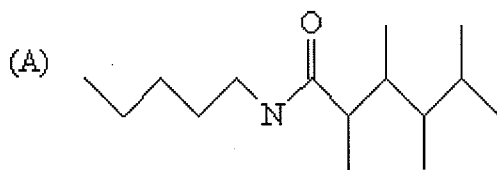
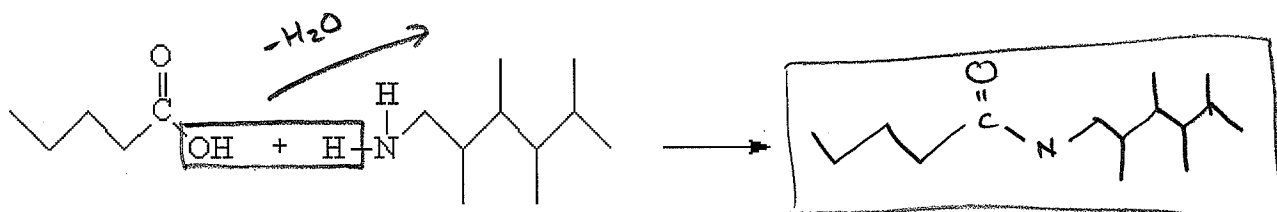
- (A) aldehyde, alcohol, ester, amine
- (B) aldehyde, alcohol, ether, amine
- (C) carboxylic acid, amine, ether, alcohol
- (D) ketone, alcohol, ester, amine
- (E) ester, carboxylic acid, alcohol, amine

27. The following is the structure of galactose. Galactose has:

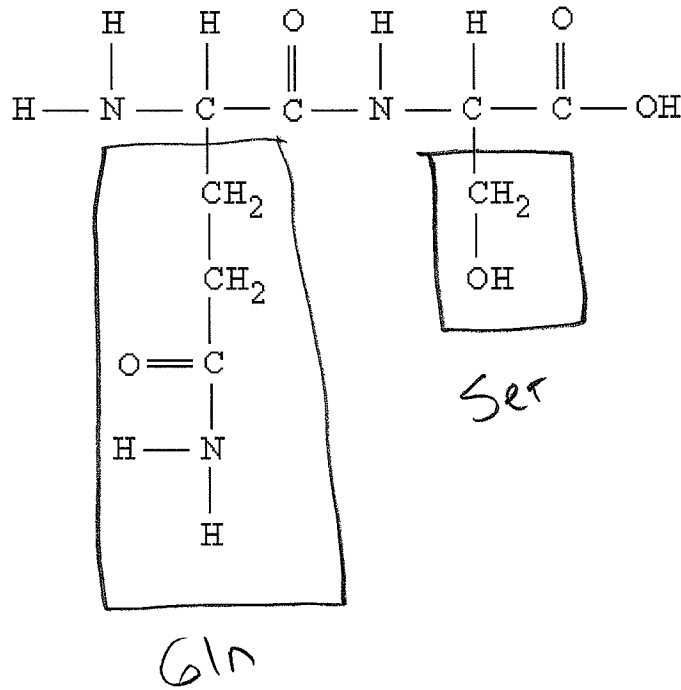


- (A) one chiral carbon
- (B) two chiral carbons
- (C) four chiral carbons
- (D) five chiral carbons
- (E) six chiral carbons

28. Complete the following condensation reaction:

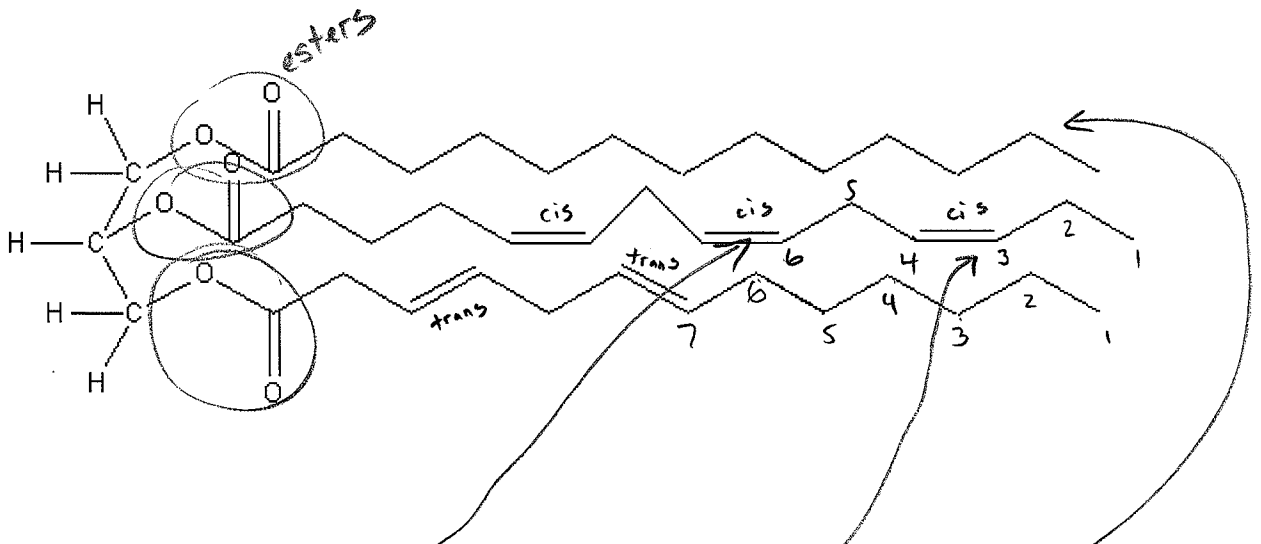


29. The structure below is:



- (A) Ser-Ala
- (B) Ala-Ser
- (C) Gln-Ser
- (D) Ser-Gln
- (E) Bye-Bye

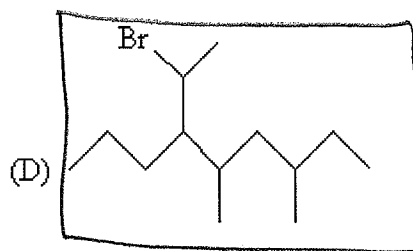
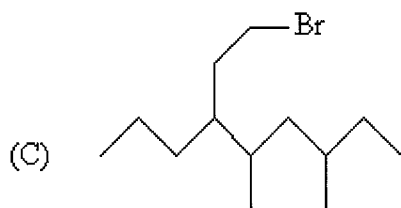
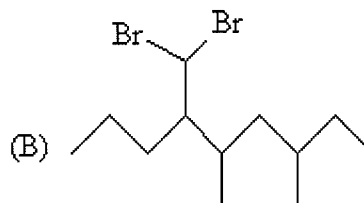
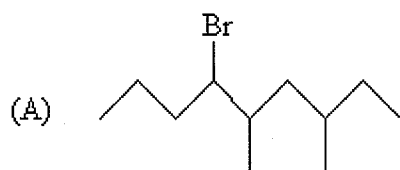
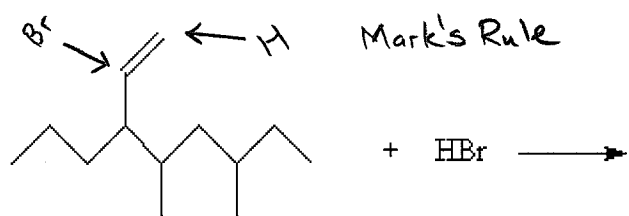
30. Consider the fat molecule below. Which of the following is **false**?

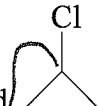


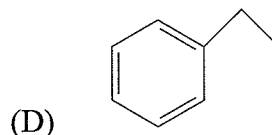
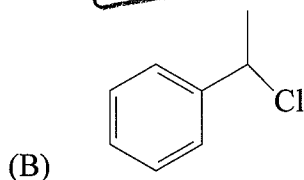
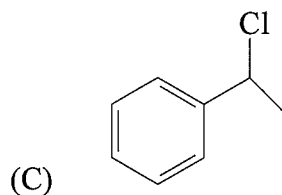
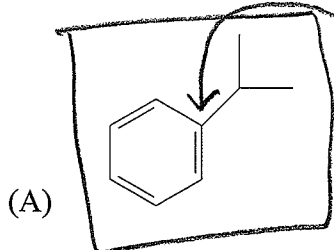
- (A) This fat is an omega-6 fat True
- (B) This fat contains 3 cis- and 2 trans- bonds True
- (C) This fat is an omega-3 fat True
- (D) This fat contains three ether groups False
- (E) One carbon chain is saturated True

This chain is saturated with hydrogens (all C-C single bonds)

31. Complete the following addition reaction:



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



33. Because of Chemistry 123...

- (A) I now understand *entropy* is responsible for the current state of my life.
(B) I have a blister on my brain.
(C) My pick-up lines now include the words *titrate*, *conjugate*, *dissociate*, and *buffer system*.
(D) My family loves me again.
(E) I'm fatigued, famished, down in the dumps, alone, sore, oh, wait, **Chemistry** 123... I'm ecstatic, satisfied, lucky, healthy, and socially content.

[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 :)