Grade 12 Chemistry Exam Review

1. What is the difference between the following pairs:
   a) Exothermic and Endothermic
   b) Ionization and Dissociation
   c) Enthalpy and Entropy
   d) Potential Energy and Kinetic Energy
   e) Ionic Bonds and Covalent Bonds
   f) Open systems and Closed systems
   g) Properties of Acids and Properties of Bases
   h) Arrhenius Acid/Base, Bronsted-Lowry Acid/Base, and Lewis Acid/Base
   i) Saturated, Unsaturated, and saturated solution
   j) Reduction and Oxidation
   k) Reducing Agent and Oxidizing Agent
   l) Electrolysis and Electrolytic Cells
   m) Anode and Cathode
   n) Kinetic Energy and Potential Energy
2. Calculate the energy required to raise the temperature of 200 g of water from 13°C to 45°C.
3. Calculate the energy released when the temperature of water is changed from 69°C to 23°C.
4. Draw a bomb calorimeter and explain how it works.
5. A 7.9 g sample of benzoic acid (C_6H_5COOH) is burned in a bomb calorimeter. The reaction produced enough heat to raise the temperature of the water in the calorimeter by 3.98°C. The calorimeter holds 4.56 L of water and the calorimeter is 1430 g. The specific heat of the calorimeter is 0.924 J/g°C. Determine the heat of reaction. Calculate the molar heat of reaction of benzoic acid. Write the thermochemical equation for the combustion of benzoic acid.
6. A 3.21 g sample of acetylene, C_2H_2, was burned in a calorimeter containing 5.8 L of water. After the combustion the temperature rose from 7.9°C to 23.8°C. The heat capacity of the calorimeter is 0.567 J/g°C and weighs 465g. Determine the molar heat of reaction and write the thermochemical equation for the reaction.
7. A 25g sample of Ethane, C_2H_6, was burned in a calorimeter containing 5.8 L of water. After the combustion the temperature rose from 7.9°C to 23.8°C. The heat capacity of the calorimeter is 0.224 J/g°C and weighs 438 g. Determine the molar heat of reaction and write the thermochemical equation for the reaction.
8. A 900 g sample of propane, C_3H_8, was burned in a calorimeter containing 200L of water. After the combustion the temperature rose from 20°C to 55 °C. The heat capacity of the calorimeter is 0.889 J/g°C and weighs 4.86 Kg. Determine the molar heat of reaction and write the thermochemical equation for the reaction.
9. Using the table in your book determine the ΔH of the following reactions
   a) $2F_2 + 2H_2O \rightarrow 4HF + O_2$
   b) $CS_2 + 2H_2O \rightarrow CO_2 + 2H_2S$
   c) $C_2H_4 + H_2 \rightarrow C_2H_6$
   d) $10N_2O + C_3H_8 \rightarrow 10N_2 + 3CO_2 + 4H_2O$
10. From the following information calculate the ΔH of formation of nitrogen monoxide (NO)
    $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ $\Delta H = -1170$ kJ
    $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$ $\Delta H = -1530$ kJ
11. From the following three thermochemical equations:
    $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ $\Delta H = -25$ kJ
    $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$ $\Delta H = -47$ kJ
    $Fe_3O_4 + CO \rightarrow 3FeO + CO_2$ $\Delta H = 38$ kJ
    Calculate the enthalpy change for the reaction
    $FeO + CO \rightarrow Fe + CO_2$

12. Use the following equations to find the enthalpy change of the formation of methane, CH_4, from chloroform, $CHCl_3$.

    $CHCl_3 + 3HCl \rightarrow CH_4 + 3Cl_2$

    $\frac{1}{2} H_2 + \frac{1}{2} Cl_2 \rightarrow HCl$ $\quad \Delta H = -92.3$ kJ

    $C + 2H_2 \rightarrow CH_4$ $\quad \Delta H = -74.8$ kJ

    $C + \frac{1}{2} H_2 + 3/2\ Cl_2 \rightarrow CHCl_3$ $\quad \Delta H = -134.5$ kJ

13. Ethene, C_2H_4, reacts with water to form ethanol, CH_3CH_2OH.

    $C_2H_4 + H_2O \rightarrow CH_3CH_2OH$

    Determine the enthalpy change of this reaction, given the following thermochemical equations.

    $CH_3CH_2OH + O_2 \rightarrow 3H_2O + 2CO_2$ $\quad \Delta H = -1367$ kJ

    $C_2H_4 + 3O_2 \rightarrow 2H_2O + 2CO_2$ $\quad \Delta H = -1411$ kJ

14. Calculate the enthalpy change of the following reaction between nitrogen gas and oxygen gas, given the following thermochemical equations.

    $2N_2 + 5O_2 \rightarrow 2N_2O_5$

    $2H_2 + O_2 \rightarrow 2H_2O$ $\quad \Delta H = -572$ kJ

    $N_2O_5 + H_2O \rightarrow 2HNO_3$ $\quad \Delta H = -77$ kJ

    $\frac{1}{2} N_2 + 3/2\ O_2 + \frac{1}{2} H_2 \rightarrow HNO_3$ $\quad \Delta H = -174$ kJ

15. Find the ΔH for the formation of N_2O_5 using bond energies.
16. Find the ΔH for the formation of CH_3CH_2OH using bond energies.
17. Find the ΔH for the formation of C_2H_4 using bond energies.
18. Discuss the difference between potential and kinetic energy.
19. Discuss the kinetic and potential energies associated with bond breaking, bond forming, exothermic and endothermic reactions.
20. Explain the collision theory.
21. Explain using the collision theory all the things that can change the rate of reaction.
22. The following data were collected for the reaction

    $M + N \rightarrow P + Q$

Initial Concentration (mol/L) [M]	Initial Concentration (mol/L) [N]	Initial Rate of Disappearance of M
0.010	0.010	2.5×10^{-3}
0.020	0.010	5.0×10^{-3}
0.020	0.030	4.5×10^{-2}

What is the rate law for the reaction? Find the X value (exponents). What is the value of the rate constant?

23. The formation of small amounts of nitric oxide, NO, in automobile engines is the first step in the formation of smog. Nitric oxide is readily oxidized to nitrogen dioxide by the reaction $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$. The following data were collected in a study of the rate of this reaction.

Initial Concentrations (mol/L) $[O_2]$	Initial Concentrations (mol/L) [NO]	Rate of Formation of NO_2 (mol/Ls)
0.0010	0.0010	7.10
0.0040	0.0010	28.4
0.0040	0.0030	255.6

What is the rate law for the reaction? Find the X value (exponents). What is the rate constant?

24. At a certain temperature the following data were collected for the reaction

$2ICl + H_2 \rightarrow I_2 + 2HCl$.

Initial Concentrations (mol/L) [ICl]	Initial Concentrations (mol/L) [H_2]	Initial Rate of Formation of I_2 (mol/Ls)
0.10	0.10	0.0015
0.20	0.10	0.0030
0.10	0.050	0.00075

Determine the rate law and the rate constant for the reaction. Find the X value (exponents).

25. The following data were obtained for the reaction of $(CH_3)_3CBr$ with hydroxide ion at 55°C.

$(CH_3)_3CBr + OH^- \rightarrow (CH_3)_3COH + Br^-$

Initial Concentrations (mol/L) [$(CH_3)_3CBr$]	Initial Concentrations (mol/L) [OH^-]	Initial Rate of Formation of $(CH_3)_3COH$
0.10	0.10	1.0×10^{-3}
0.20	0.10	2.0×10^{-3}
0.30	0.10	3.0×10^{-3}
0.10	0.20	1.0×10^{-3}
0.10	0.30	1.0×10^{-3}

What is the rate law for the reaction? Find the X value (exponents). What is the value of the rate constant at this temperature?

26. What is the Law of Mass action and how does it relate to the rate laws? Does it relate to mechanisms and how?
27. Draw and understand the E_k diagrams and the E_p diagrams. State all the areas and the effects of different situations: raise in temperature, adding a catalyst. Be able to find the activation energy of endothermic and exothermic reactions as well as the ΔH for the reaction.
28. Carbon monoxide, CO, reacts with nitrogen dioxide, NO_2. Carbon dioxide, CO_2, and nitric oxide, NO are formed. Draw a potential energy diagram to illustrate the progress of the reaction. Label the axes, the transition state, and the activated complex. Indicate the activation energy of the forward reaction, $E_{a(fwd)}$ = 134 kJ, as well as ΔH = -226 kJ. Calculate the activation energy of the reverse reaction, $E_{a(rev)}$, and show it on the graph.
29. Show using a graph how an amount of product can be increased with the addition of heat to a reaction.
30. Using LeChatelier's Principle what would happen to the direction of the following equation

$2NO_2 \rightarrow N_2O_4 + Heat$

a) Add more NO_2 to the system
b) Add more N_2O_4 to the system
c) Remove some N_2O_4 from the system
d) Remove some NO_2 from the system
e) Add more heat to the system
f) Remove more heat from the system
g) Increase the pressure
h) Decrease the pressure
i) Increase the pressure by adding He
j) Adding a catalyst

31. Using LeChatelier's Principle what would happen to the direction of the following equation

$N_2 + 3H_2 + Heat \rightarrow 2NH_3$

a) Add more N_2 to the system
b) Add more H_2 to the system
c) Remove some $H_2$from the system
d) Remove some N_2 from the system
e) Add more heat to the system
f) Remove more heat from the system
g) Increase the pressure
h) Decrease the pressure

i) Increase the pressure by adding He
j) Adding a catalyst

32. If 2.00 moles of H_2 and 3.00 moles of N_2 are placed in a reaction vessel, they will produce 0.6 moles of NH_3 at equilibrium. What is equilibrium constant for this reaction? (include units)
33. 2.00 moles of H_2 is mixed with 3.00 moles of N_2 in a 5L reaction vessel. The system is allowed to come to equilibrium at 300°C. At this temperature, 33.9% of the Hydrogen is consumed in the reaction. What is the equilibrium constant for this reaction at this temperature (include the units)?

    $N_2 + 3H_2 \rightarrow 2NH_3$

34. In the reaction $PCl_5 \rightarrow PCl_3 + Cl_2$ an equilibrium is established at 500°C. Determine the equilibrium concentration of PCl_5, if the concentration of PCl_3 and Cl_2 were both 0.53 mol/L and the Kc of the expression is 0.054.
35. 3.5 moles of HI, H_2, and I_2 are placed in a 2.0 L container and allowed to come to equilibrium at 520°C. What is the equilibrium concentration of each substance if the Kc for the reaction is 0.0156?
36. The equilibrium constant Kc, for the reaction $SO_3 + NO \rightarrow NO_2 + SO_2$ was found to be 0.500 at a certain temperature. If 0.300 mol of SO_3 and 0.300 mol of NO were placed in a 2.00 L container and allowed to react, what would be the equilibrium concentration of each gas?
37. The reaction $2HCl \rightarrow H_2 + Cl_2$ has a Kc equal to 3.2×10^{-34} at 25°C. If the reaction vessel contains initially 2.00 mol/L of HCl and is allowed to come to equilibrium, what will be the concentration of H_2 and Cl_2?
38. Are the following reactions spontaneous or not? Give reasons by examining the ΔH, ΔG, ΔS (if possible). Include the overall Gibbs Free Energy Equation.
    a) $Ag^+_{(aq)} + Cl^- \rightarrow AgCl_{(s)}$
    b) $I_{2(s)} \rightarrow I_{2(g)}$
    c) $NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$
    d) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$
    e) $C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$
    f) $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$
39. Fill in the first column with probable to react or improbable to react. Decide whether the ΔG value is >0 or <0.

Reaction travels towards the Right.	ΔG	ΔH	$T\Delta S$	Exceptions
		-	+	No exceptions
		-	-	Low T
		+	+	High T
		+	-	No exceptions
		-	-	High T
		+	+	Low T

40. A sample of blood was found to have $[H^+] = 4.6 \times 10^{-8}$ mol/L. Find the molar concentration of OH^-, the pH and the pOH of the solution.
41. An aqueous solution of baking soda has a molar concentration of hydroxide ions of 7.8×10^{-6} mol/L. What is the molar concentration of hydrogen ions and the pH of the solution?
42. The concentration of a sample of vinegar was found to be 0.75 mol/L acetic acid, CH_3COOH. Calculate the values of $[H^+]$ and pH if the Ka = 1.8×10^{-5}.
43. A 0.0100 mol/L solution of butyric acid has a pH of 3.4. Calculate Ka of this acid. ($C_3H_7O_2H$)
44. Calculate the pH of a solution resulting from dissolving 3.8 mole of butyric acid, $C_3H_7O_2H$, and 1.8 moles of $NaC_3H_7O_2$ in 0.78L of water. The Ka for butyric acid is 1.7×10^{-5}.
45. Determine the volume of 0.453 mol/L H_2CO_3 required to neutralize 76 mL of 0.841 mol/L NaOH?

46. Determine the volume of 3.56 mol/L H_3PO_4 required to neutralize 456 mL of 2.2 mol/L LiOH?
47. A student found that 36.7 mL of 0.220 mol/L NaOH was required to neutralize 0.68 g of a monoprotic organic acid. Determine the molar mass of the unknown acid.
48. How would you choose an appropriate indicator for a titration? Include the titration curves for buffers and be able to explain the difference between a strong acid/strong base titration, a strong acid/weak base titration, and a strong base/weak acid titration curve.
49. Calculate the pH, pOH, and $[OH^-]$ of
    a) 0.30 M $LiCH_3COO$ solution
    b) 0.25 M $NaNO_2$ solution
    c) 0.35 M K_2SO_3 solution
    d) 0.53 M Li_2CO_3 solution
50. A solution was made by dissolving 0.837 g $Ba(OH)_2$ in 100 mL final volume. If $Ba(OH)_2$ is fully broken up into its ions, what is the pOH and the pH of this solution?
51. Ethylamine, $CH_3CH_2NH_2$, has a strong, pungent odor similar to that of ammonia. Like ammonia, it is a Bronsted base. A 0.10 M solution has a pH of 11.86. Calculate the K_a for ethylamine, and find the K_a for its conjugate acid, $CH_3CH_2NH_3^+$.
52. Calculate the number of grams of NH_4Br that have to be dissolved in 1.00L of water at 25°C to have a solution with a pH of 5.15.
53. Lactic acid, $CH_3CHOHCOOH$, is a monoprotic acid that is produced by muscle activity. It is also produced from milk by the action of bacteria. What is the pH of a 0.12 mol/L solution of lactic acid if the K_a is 1.4×10^{-4}?
54. Oxalic acid, HOOCCOOH is a weak diprotic acid that occurs naturally in some foods, including rhubarb. Calculate the pH of a solution of oxalic acid that is prepared by dissolving 2.5 g in 1.0 L of water. What is the concentration of hydrogen oxalate, $HOOCCOO^-$, in the solution? $K_a = 5.6 \times 10^{-2}$.
55. What is a buffer?
56. Write all chemical equations and equilibrium constants present in the following buffer systems.
    a) $HC_2H_3O_2/NaC_2H_3O_2$
    b) $H_2PO_4^-/NaHPO_4^-$
    c) $HC_7H_5O_2/K\ C_7H_5O_2$
    d) $CH_3COOH/NaCH_3COO$
57. Calculate the pH of a buffered solution make up as 0.015 M sodium acetate and 0.10 M acetic acid in 1.00 L of solution. What is the new pH if 0.0026 moles of HNO_3 are added to the mix?
58. Calculate the pH of a buffered solution make up as 0.036 M Potassium Benzoate ($KC_7H_5O_2$) and 0.17 mol of benzoic acid ($HC_7H_5O_2$) in 1.25 L of solution. What is the new pH if 0.004 moles of HCl are added to the mix?
59. A buffer solution was prepared by dissolving 2.5 g of ammonium chloride in 125 mL of 0.24 M ammonia. At what pH will this solution serve as a buffer? If you were to add 0.002 moles of HCl what is the new pH?
60. Calculate the pH of a buffered solution make up as 0.015 M sodium acetate and 0.10 M acetic acid in 1.00 L of solution.
61. A buffer solution was prepared by dissolving 2.5 g of ammonium chloride in 125 mL of 0.24 M ammonia. At what pH will this solution serve as a buffer?
62. Determine the Ksp of a saturated solution of $CaCl_2$, when the solution is 0.049 mol/L.
63. To form a saturated solution of $Al_2(SO_4)_3$ a student dissolved 0.046 mole of the salt in 2.68 L of water. Determine the Ksp for this reaction.
64. If I were to dissolve 5.6 g of LiOH in 400 mL of water to form a saturated solution, find the Ksp of LiOH.
65. What is the Ksp of $CuBr_2$ if I can dissolve 0.54 mol of $CuBr_2$ in 600 mL of 0.1 mol NaBr?
66. The Ksp of Zinc nitrate is 8.6×10^{-5}. Calculate the concentration of a saturated solution of zinc nitrate.

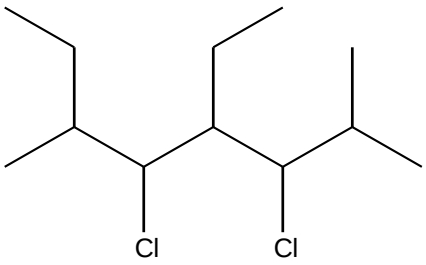
67. The Ksp of $Cu(ClO_3)_2$ is 6.7×10^{-12}. Calculate the molar solubility of $Cu(ClO_3)_2$ in a 0.596 mol/L solution of $Ba(ClO_3)_2$.
68. Copper (I) Chloride has $K_{sp} = 1.9 \times 10^{-7}$. Calculate the molar solubility of CuCl in
    a) pure water
    b) 0.020 M HCl
    c) 0.020 M $MgCl_2$
69. Will a precipitate form if 20.0 mL of a 0.002 mol/L solution of $Pb(ClO_3)_2$ is added to 300.0 mL of 0.003 mol/L of $ZnSO_4$. Ksp $PbSO_4 = 5.9 \times 10^{-11}$
70. Will a precipitate form if 20.0 mL of a 0.012 mol/L soluiton of $Hg(ClO_3)_2$ is added to 38.0 mL 0.045 mol/L of $ZnCl_2$. Ksp $HgCl_2 = 5.9 \times 10^{-7}$
71. The Ksp of aluminium fluoride is 5.3×10^{-4}. Calculate the molar solubility in mol/L.
72. Balance the following Redox equations.
    a) $HBr + H_2SO_4 \text{ -----> } Br_2 + SO_2 + H_2O$
    b) $KMnO_4 + HBr \text{ -----> } Br_2 + MnBr_2 + KBr + H_2O$
    c) $KMnO_4 + H_2S + H_2SO_4 \text{ ---> } S + MnSO_4 + K_2SO_4 + H_2O$
    d) $Fe + HNO_3 \text{ ---> } Fe(NO_3)_2 + NO + H_2O$
    e) $HBr + K_2Cr_2O_7 \text{ -----> } CrBr_3 + KBr + Br_2 + H_2O$
    f) $FeCl_2 + KNO_3 + HCl \text{ ----> } FeCl_3 + NO + H_2O + KCl$
    g) $K_2Cr_2O_7 + CH_3OH + H_2SO_4 \text{ --> } Cr_2(SO_4)_3 + K_2SO_4 + HCOOH + H_2O$
    h) $KClO_2 + KBiO_3 + HClO_3 \text{ ---> } Bi(ClO_3)_3 + KClO_3 + H_2O$
    i) $F_2 + KOH \text{ --> } KF + F_2O + H_2O$
73. Balance the following equations in an acidic environment and a basic environment.
    a) $Sr + Ce^{3+} \rightarrow Sr^{2+} + Ce$
    b) $MnO_4^- + C_2O_4^{2-} \rightarrow CO_2 + MnO_2$
    c) $CN^- + IO_3 \rightarrow CNO^- + I^-$
    d) $Mn^{2+} + HBiO_3 \rightarrow Bi^{3+} + MnO_4^-$
74. Calculate the Ecell for the following cells and include their overall reaction equation.
    a) $Co|Co^{2+}(0.5M)||Cr|Cr^{3+}(0.9M)$ @35°C
    b) $Zn|Zn^{2+}(2.3M)||Ni|Ni^{3+}(7M)$ @78 °C
    c) $Au|Au^{3+}(1.3M)||Cu|Cu^{+}(0.3M)$ @-10 °C
    d) $Ni|Ni^{2+}(2.2M)||Cr|Cr^{2+}(1.2M)$ @27 °C
    e) $Ag|Ag^{+}(0.3M)||Fe|Fe^{2+}(0.1M)$ @300 °C

75. Draw fully labeled diagrams of electrolytic cells that include the direction of current, the anode, the cathode, the half reactions and the overall reaction
    a) $CuBr_2$
    b) LiCl
    c) $ZnCO_3$
    d) $NaNO_3$
76. Draw fully labeled diagrams of electrochemical cells that include the direction of current, the anode, the cathode, the half reactions, the salt bridge, and the overall reaction.
77. $Co|Co^{2+}||Cr|Cr^{3+}$
78. $Zn|Zn^{2+}||Ni|Ni^{3+}$
79. $Au|Au^{3+}||Cu|Cu^{+}$
80. $Ni|Ni^{2+}||Cr|Cr^{2+}$
81. $Ag|Ag^{+}||Fe|Fe^{2+}$
82. Discuss the discoveries and theories by the following scientists
    a) DeBroglie
    b) Schrodinger
    c) Heisenberg
    d) Hund
    e) Pauli

f) Einstein

83. Calculate the energy of red light with a frequency of 4.57×10^{14} Hz.
84. Calculate the energy of a light with a frequency of 6.23×10^{14} Hz.
85. Calculate the energy of blue light with a wavelength of 456 nm.
86. Calculate the energy of red light with a wavelength of 656 nm.
87. What wavelength of light will be given off if an electron in the hydrogen atom were to travel from the 4^{th} energy level back to the first energy level?
88. What wavelength of light will be given off if an electron in the hydrogen atom were to travel from the 4^{th} energy level back to the second energy level?
89. Describe the four quantum numbers and what they tell us about an element.
90. Write the electron configuration for Au, Mo, Cu, No, Sn, N
91. Draw the energy electron diagrams for Cr, Ag, Hg, Ho, Zr
92. Draw the shapes of the following molecules, be sure to include the name of the shape and the angles associated with it: SnF_4, $XeCl_6$, CH_4, NH_3, SnF_2, NH_4^+, PCl_3, PCl_5.
93. Write the structural formulae for the following organic compounds
    a) 4-chloro-3-ethyl-3-methylbutene
    b) 3,6,7-trichloro-4,5-diethyl-8,8-dimethyldecane
    c) 4,4-dichloro-3,6-dimethyloctane
    d) 3-ethyl-2,2,4,5-tetramethylhexane
    e) 1,2-dimethylbenzene
    f) 3,4-dichlorocyclohexene
    g) 4-ethyl-4,5-dimethyl-3-isopropyl-2-hexene
    h) 1-butyl-1-ethylcyclohexane
    i) 3,4,4-trichloro-2-iodo-1-butene
    j) 3-ethy-4,5-dimethyl-2-hexanol
    k) 3,4-diethyl-3,5-dimethyl-2-heptanone
    l) 5-ethyloctanoic acid
    m) 2,4-dimethylhexanoic acid
    n) 5,5,6-trimethyl-3-propyl-1-heptanal
    o) 3,4-diethylheptanal
    p) N,N-dipropylbutamine
    q) Butyl propanoate
94. Name the following organic compounds.

a)



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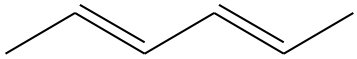

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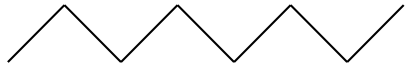

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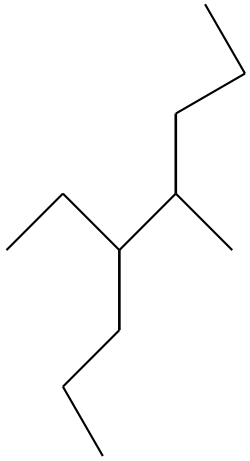

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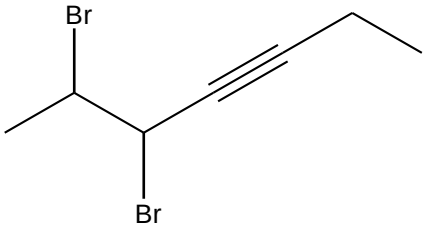

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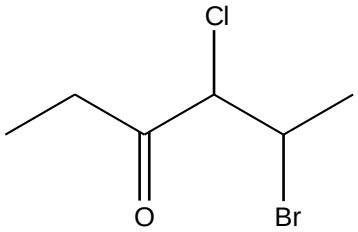

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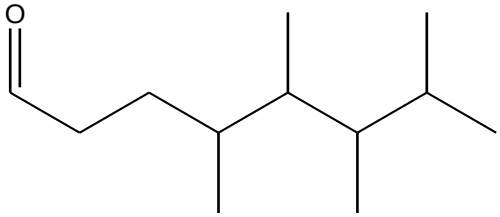

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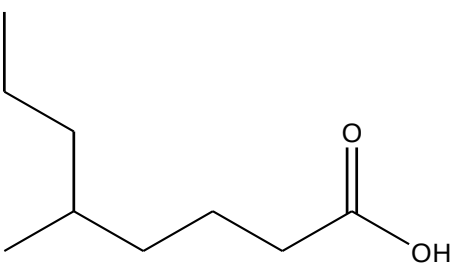

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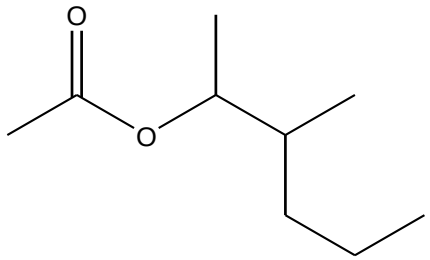
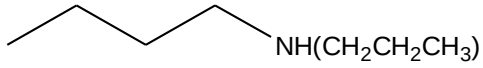
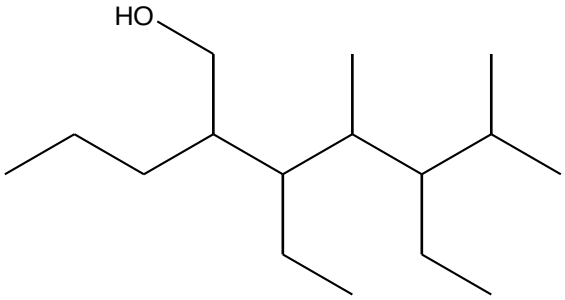


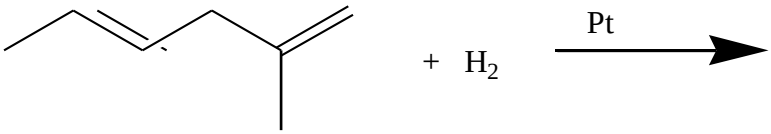
j)

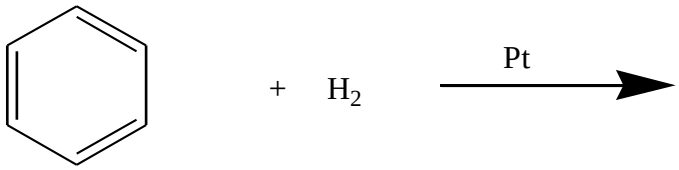


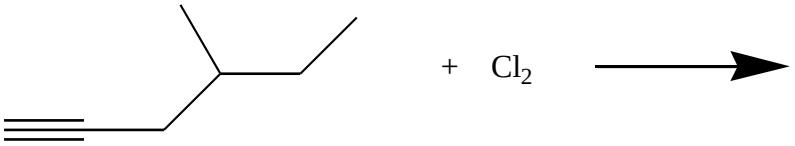
k)

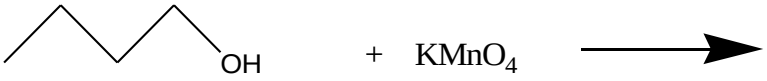


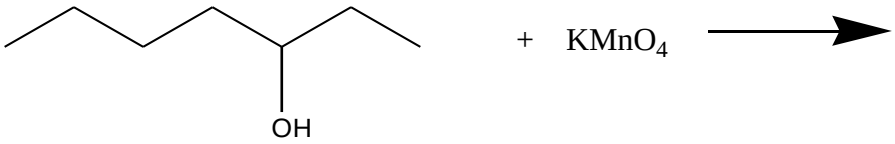
95. Write the product for the following reactions. Include the name of the reactants and products. Name the types of reactions as well.

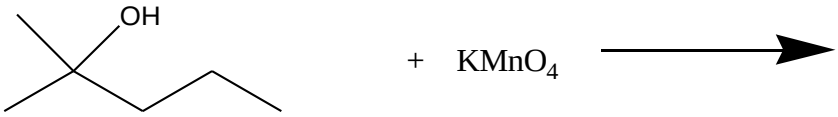


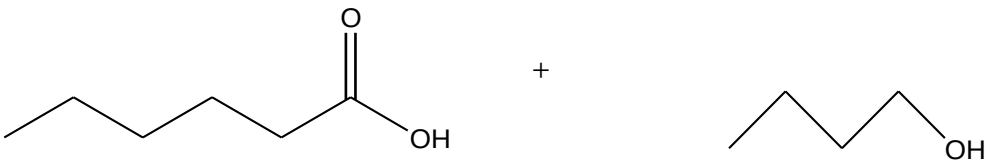


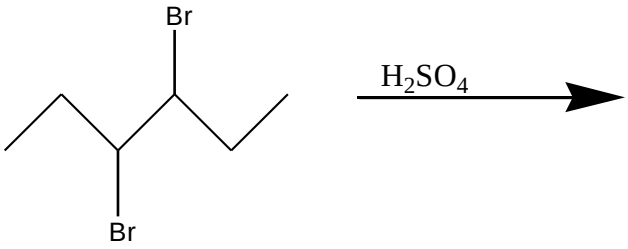




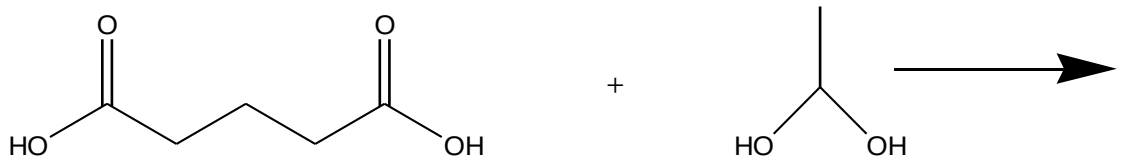








96. What will the following reaction produce?



How will it form and name some properties that it may have.