Calculate the energy change when 10.0g of ice at -15.0°C is heated to steam at -5.0°C.

$$q = mC\Delta T$$

$$q = (10.g)\left(2.01 \frac{J}{g\cdot°C}\right)(10.0°C)$$

$$q = 2.0 \times 10^2 J$$

Calculate the energy change when 10.0g of ice is converted to water.

$$m = 10.0 g \qquad \Delta H_{fus} = n H_{fus}$$
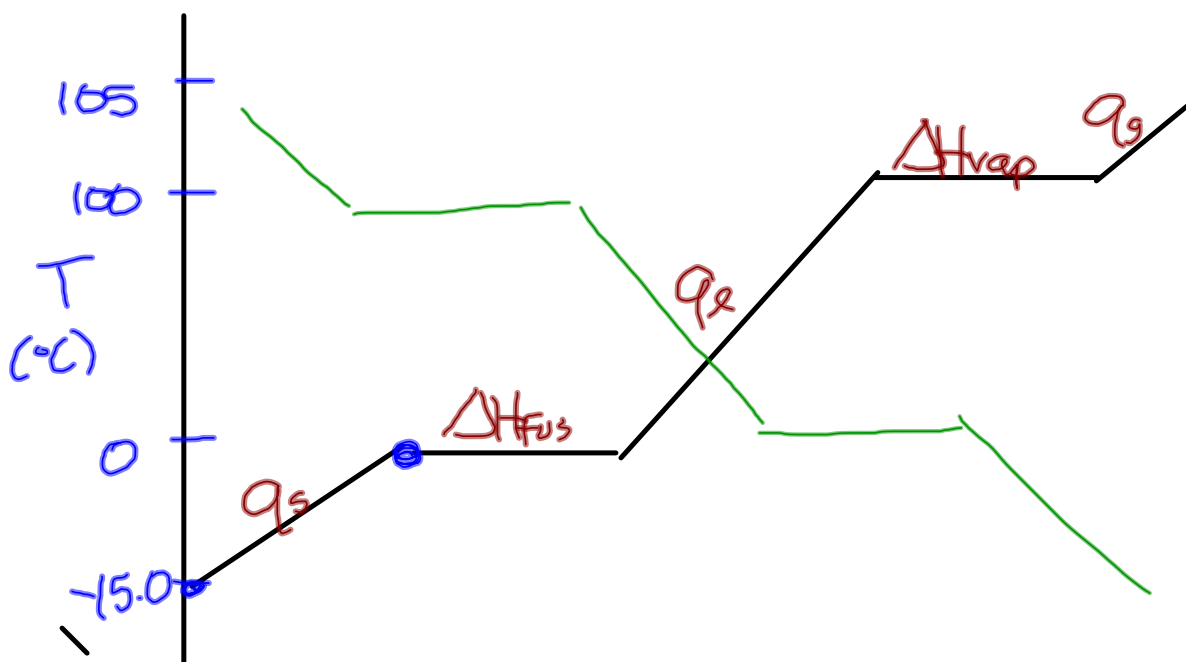
$$H_{fus} = 6.03 \frac{kJ}{mol} \qquad \Delta H_{fus} = \left(\frac{10.0 g}{18.02 g/mol} \right) \left(6.03 \frac{kJ}{mol} \right)$$

$$\boxed{\Delta H_{fus} = 3.35 \, kJ}$$

Calculate the total energy change when 10.0g of ice at -15.0°C is heated to steam at 105°C.

$$\Delta E_T = q_s + \Delta H_{fus} + q_\ell + \Delta H_{vap} + q_g$$

$$q_s = mC\Delta T$$

$$q_s = (10.0g)(2.01 \tfrac{J}{g \cdot C})(15°C)$$

$$q_s = 301.5 \ J$$

$$\Delta H_{fus} = n H_{fus}$$

$$\Delta H_{fus} = \left(\frac{10.0g}{18.02 g/mol}\right)\left(6.03 \tfrac{kJ}{mol}\right)$$
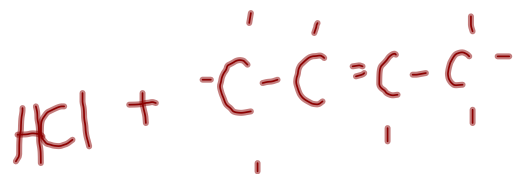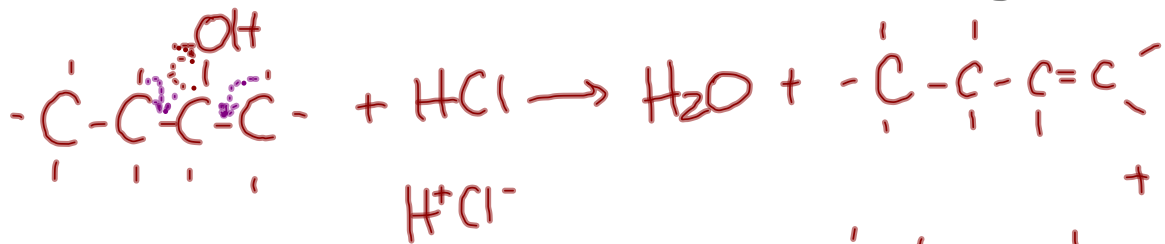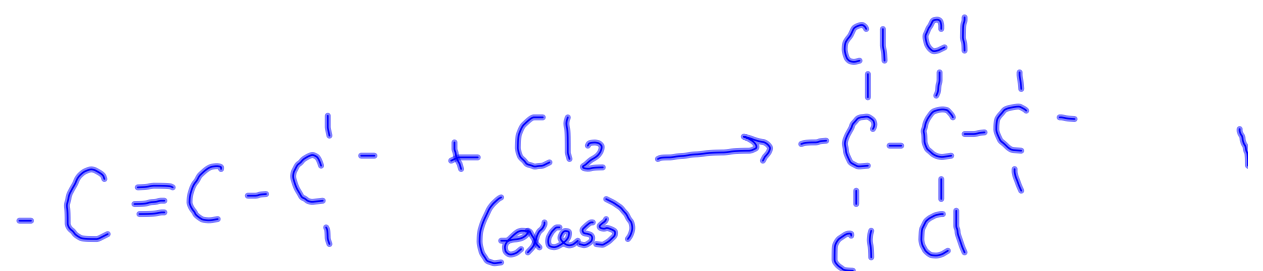
$$\Delta H_{fus} = 3.35 \ kJ$$

ESTERIFICATION

propanoic acid + 1-butanol $\longrightarrow$ water + butyl propanoate

$$-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle O \atop \|}{C}-OH \; + \; -\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-OH \; \longrightarrow \; H_2O$$

+

$$-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle O \atop \|}{C}-O-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-\overset{\displaystyle|}{\underset{\displaystyle|}{C}}-$$

ELIMINATION

2. butanol + HCl $\longrightarrow$ water + hydrogen chloride + 1-butene + 2-butene

$$-C-C-C=C- \ + \ HCl \longrightarrow H_2O \ + \ -C-C-C=C$$

$$H^+Cl^-$$

$$HCl \ + \ -C-C=C-C-$$

$$-C\equiv C-\overset{|}{\underset{|}{C}}- \ + \ H_2 \longrightarrow \ -\overset{|}{\underset{|}{C}}=\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$$

$$-C\equiv C-\overset{|}{\underset{|}{C}}- \ + \ \underset{(excess)}{Cl_2} \longrightarrow -\overset{Cl}{\underset{Cl}{C}}-\overset{Cl}{\underset{Cl}{C}}-\overset{|}{\underset{|}{C}}- \qquad \text{\textbackslash}$$

1-pentanol

(-OH)
alcohol

$$\begin{array}{ccccc} & \overset{\displaystyle OH}{|} & | & | & | \\ -\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}- & & & & \\ | & | & | & | & | \end{array}$$

pentanal

aldehyde
(=O)
end

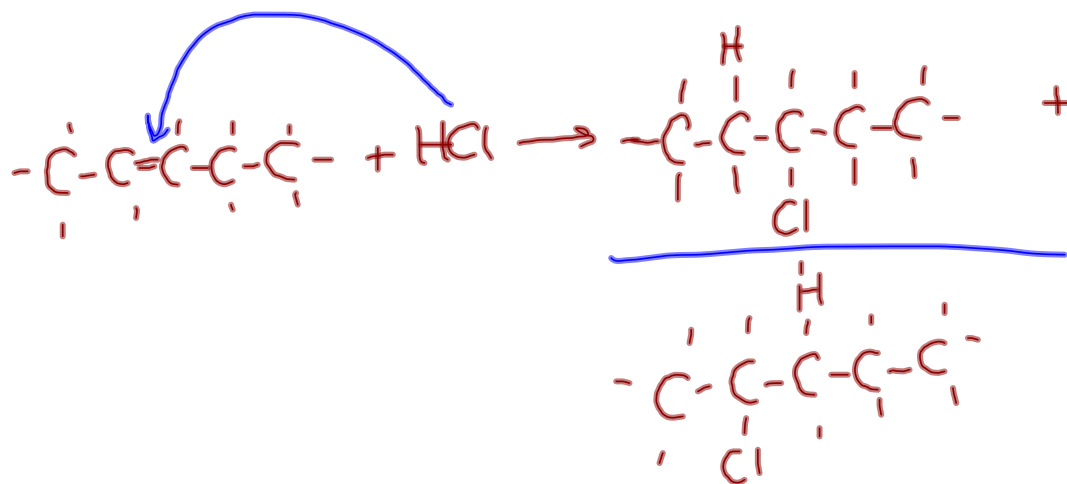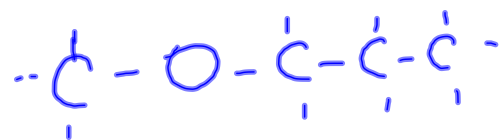$$\begin{array}{ccccc} \overset{\displaystyle O}{||} & | & | & | & | \\ -C-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}- \\ & | & | & | & | \end{array}$$
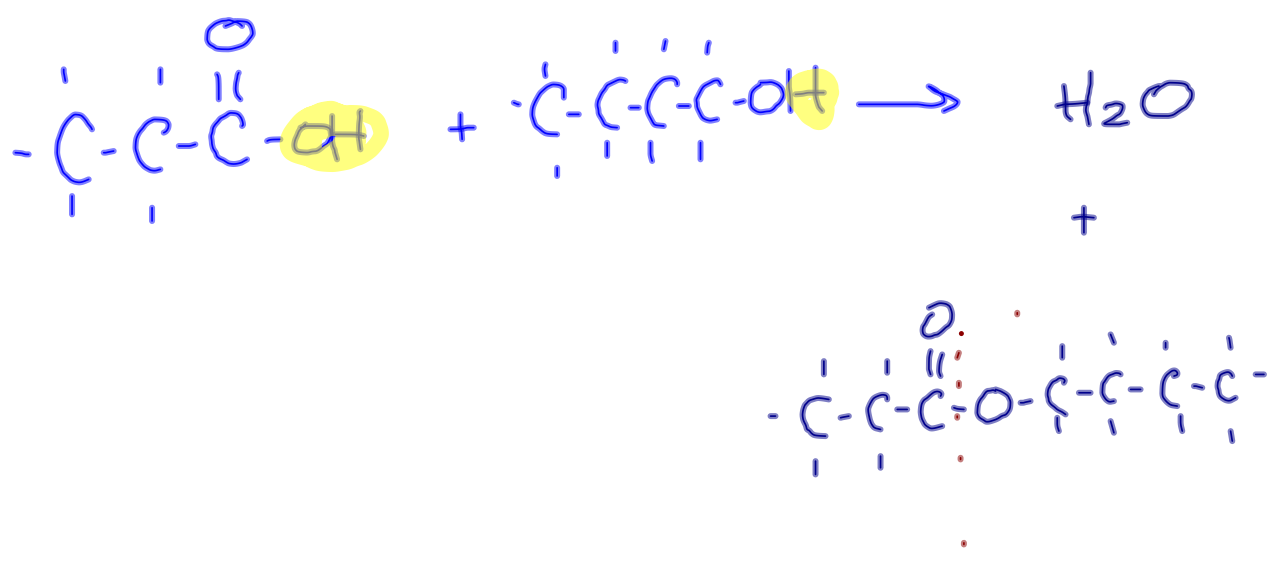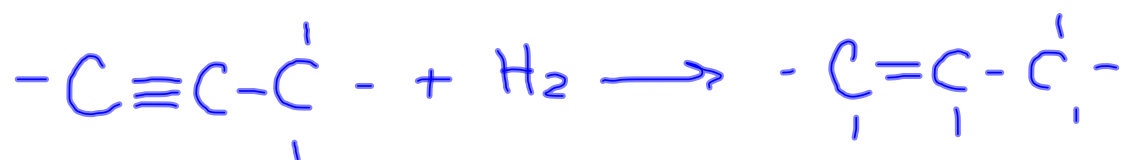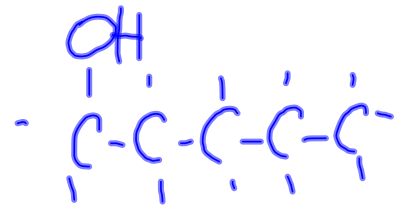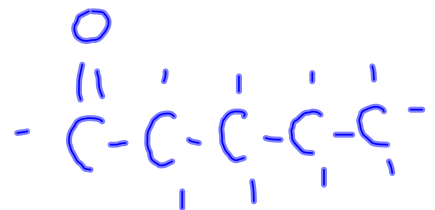
2-pentanone

Ketone

non-terminal

$$\begin{array}{ccccc} | & \overset{\displaystyle O}{||} & | & | & | \\ -\overset{|}{C}-C-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}- \\ | & & | & | & | \end{array}$$

ADDITION

2-pentene + HCl $\longrightarrow$ 2-chloropentane + 3-chloropentane

$$-\overset{|}{\underset{|}{C}}-C=\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}- \; + \; HCl \longrightarrow \sim \overset{H}{\underset{}{C}}-\overset{|}{\underset{Cl}{C}}-\overset{|}{\underset{}{C}}-\overset{|}{\underset{}{C}}-\overset{|}{\underset{}{C}}- \quad +$$

$$-\overset{|}{\underset{}{C}}-\overset{|}{\underset{Cl}{C}}-\overset{H}{\underset{}{C}}-\overset{|}{\underset{}{C}}-\overset{|}{\underset{}{C}}-$$

8

$$-\overset{|}{\underset{|}{C}} - O - \overset{|}{\underset{|}{C}} - \overset{|}{\underset{|}{C}} - \overset{|}{\underset{|}{C}} -$$

methylpropyl ether

$$\overset{}{\underset{|}{C}_1} = \overset{|}{\underset{}{C}_2} - \overset{|}{\underset{|}{C}_3} - \overset{|}{\underset{|}{C}_4} - \overset{|}{\underset{|}{C}_5} -$$ 4-methyl-1-pentene

CH_3

$$\overset{|}{\underset{|}{C}_1} = \overset{|}{\underset{|}{C}_2} - \overset{|}{\underset{|}{C}_3} - \overset{|}{\underset{|}{C}_4} - \overset{|}{\underset{|}{C}_5} -$$ 3-phenyl-1-pentene
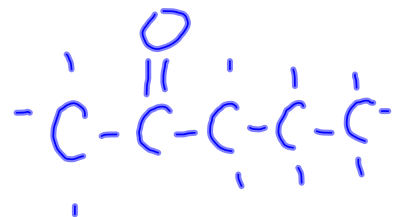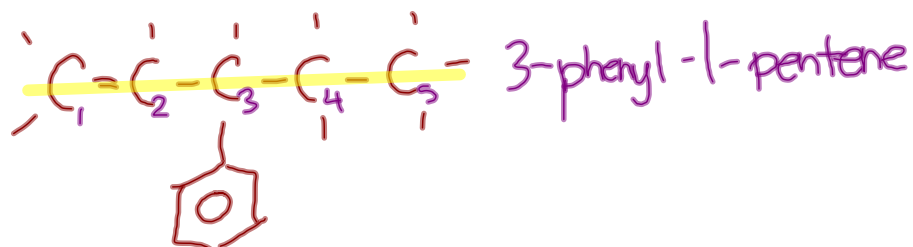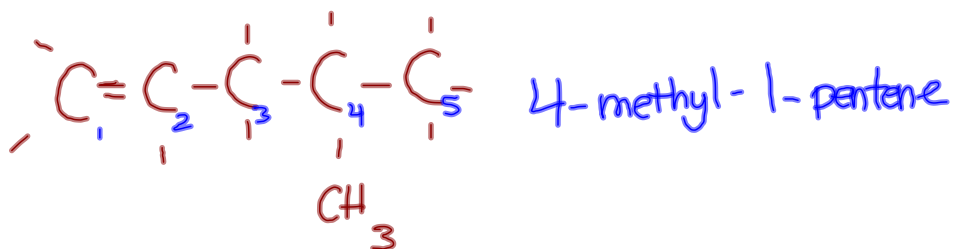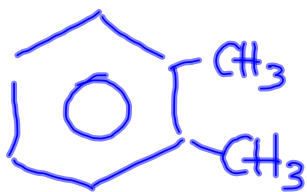
ortho-dimethyl benzene
(1,2)
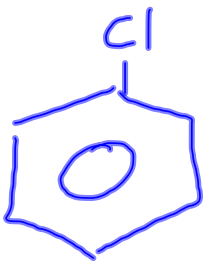
10.0g ice @ -15.0°C → steam 100.°C

ice @ 0.0°C   Steam 161°C

T (°C)

161 —
100 —
0.0 —

ΔH_{fus}

q_ℓ

ΔH_{vap}

q_g
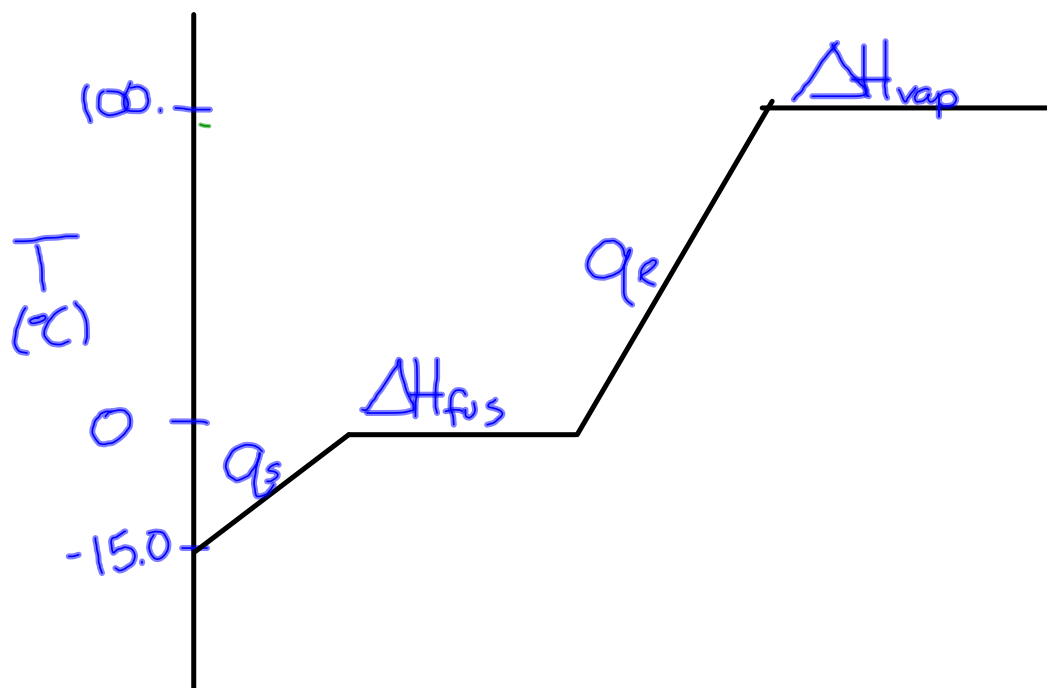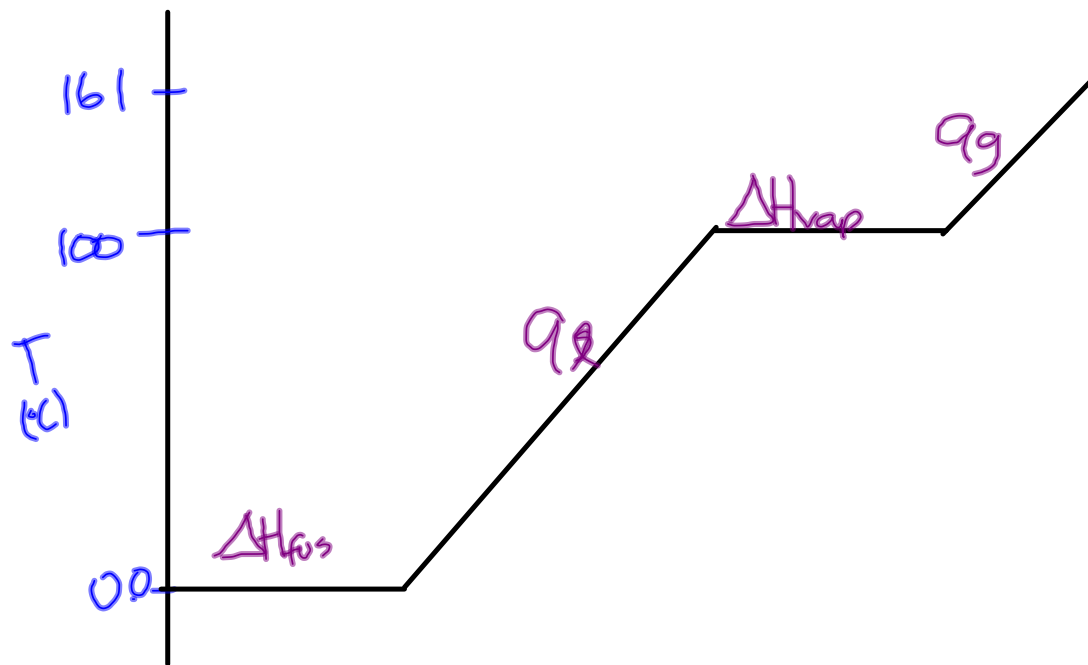
103g
Block of copper @ 97.0°C into 60.0g water
@ 18.0°C.

$T_f = ?$

$$q = -q$$

$$mC\Delta T = -mC\Delta T$$

$$(103g)(0.385\tfrac{J}{g\cdot°C})(T_f-97.0°C) = -(60.0g)(4.19\tfrac{J}{g\cdot°C})(T_f-18.0°C)$$

$$23.1\,T_f - 2240.7 = -251.4\,T_f + 4525.2$$

$$23.1\,T_f + 251.4\,T_f = 2240.7 + 4525.2$$

$$274.5\,T_f = 6765.9$$
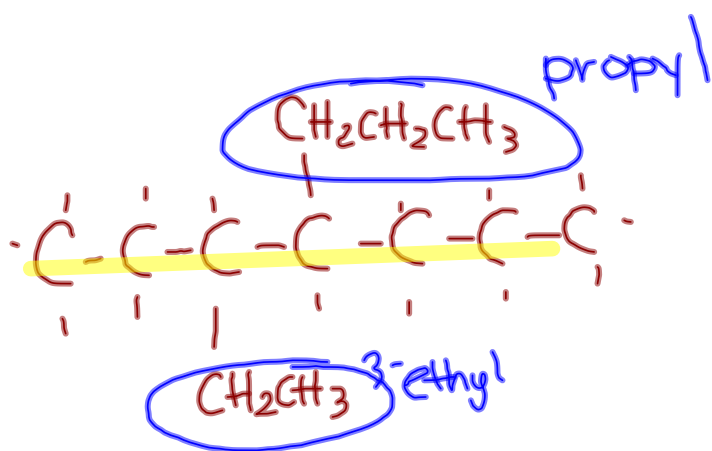
$$\boxed{T_f = 24.6°C}$$

$$3(2)(x-3) = -(4)(1)(x-2)$$
$$6x - 18 = -4x + 8$$
$$6x + 4x = 18 + 8$$
$$10x = 26$$
$$x = \frac{13}{5}$$
$$x = 2.6$$

propyl

$CH_2CH_2CH_3$

$-C-C-C-C-C-C-C-$

CH_2CH_3 3-ethyl

heptane

3-ethyl-propylheptane

$$C = C \quad + HCl$$

8.50 g of NaCl is added to a simple calorimeter containing 150.mL of water at 21.6°C. The temperature of the water increases to 23.8°C. Determine the molar enthalpy of solution.

$$\Delta H_s = -q$$

$$nH_s = -vC\Delta T$$

$$\left(\frac{8.50g}{58.44 g/mol}\right)H_s = -(0.150L)\left(4.19\frac{kJ}{L\cdot °C}\right)(2.2°C)$$

$$H_s = \frac{-(0.150L)\left(4.19\frac{kJ}{L\cdot °C}\right)(2.2°C)}{\left(\frac{8.50g}{58.44 g/mol}\right)}$$

$$H_s = -9.51 \frac{kJ}{mol}$$

A 160. g block of copper at 85.0°C is added to a simple calorimeter containing 75.0 g of water at 21.0°C. What is the final temperature of the solution?

$$q_{Cu} = -q_{H_2O}$$

$$mC\Delta T = -mC\Delta T$$

$$(160.g)\left(0.385\tfrac{J}{g\cdot C}\right)(T_F - 85.0°C) = -(75.0g)\left(4.19\tfrac{J}{g\cdot C}\right)(T_F - 21.0°C)$$

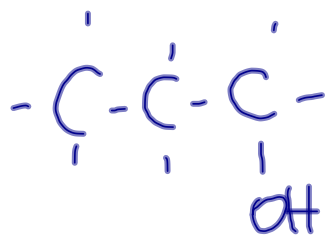$$61.6\, T_F - 5236 = -314.25\, T_F + 6599.25$$

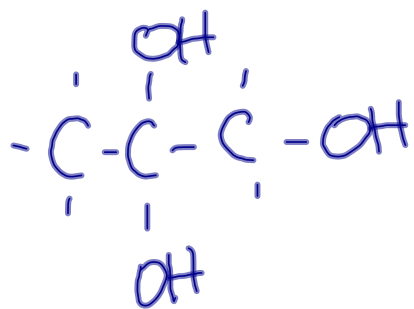$$61.6\, T_F + 314.25\, T_F = 6599.25 + 5236$$

$$375.85\, T_F = 11\,835.25$$

$$T_F = \frac{11\,835.25}{375.85}$$

$$\boxed{T_F = 31.5°C}$$
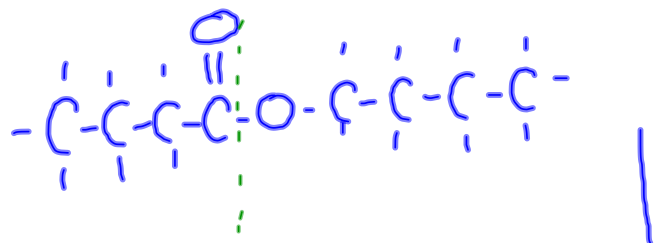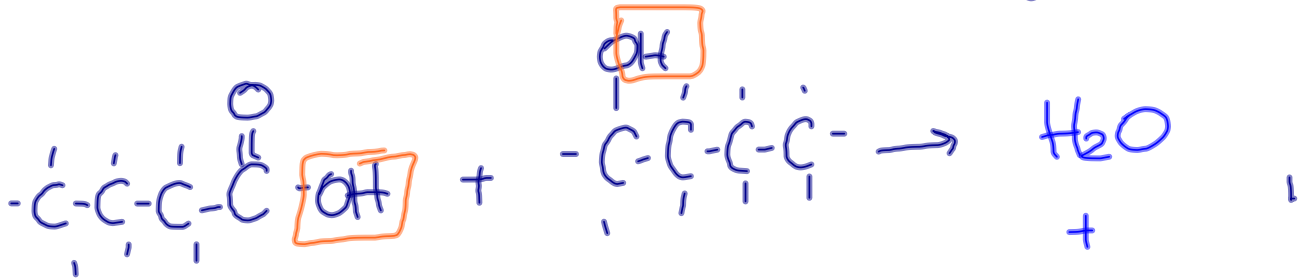
Alcohol - R-OH

$-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{OH}{C}}-$ 1-propanol

$-\overset{|}{\underset{|}{C}}-\overset{OH}{\underset{|}{C}}-\overset{|}{\underset{OH}{C}}-OH$ 1,2,2-propanetriol

ESTERIFICATION

12 butanoic acid + 1-butanol $\longrightarrow$ water + butyl butanoate

$-\overset{O}{\overset{\|}{C}}-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-$ OH $+$ $-\overset{OH}{\overset{|}{C}}-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-$ $\longrightarrow$ H_2O

$+$

$-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-\overset{O}{\overset{\|}{C}}-O-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-\overset{|}{C}-$

⑤ $2Al_{(s)} + 3Cl_{2(g)} \longrightarrow 2AlCl_{3(s)}$

$\Delta H = ?$

① $2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$
$\Delta H = -1049 \text{ kJ}$

② $HCl_{(g)} \longrightarrow HCl_{(aq)}$ $\Delta H = -74.8 \text{ kJ}$

③ $H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}$ $\Delta H = -1845 \text{ kJ}$

④ $AlCl_{3(s)} \longrightarrow AlCl_{3(aq)}$ $\Delta H = -323 \text{ kJ}$

③ × 3
⑤ $3H_{2(g)} + 3Cl_{2(g)} \longrightarrow 6HCl_{(g)}$ $\Delta H = -5535 \text{ kJ}$

Rev④ × 2
⑥ $2AlCl_{3(aq)} \longrightarrow 2AlCl_{3(s)}$ $\Delta H = 646 \text{ kJ}$

② × 6
⑦ $6HCl_{(g)} \longrightarrow 6HCl_{(aq)}$ $\Delta H = -448.8 \text{ kJ}$

① + ⑤ + ⑥ + ⑦
$2Al_{(s)} + 3Cl_{2(g)} \longrightarrow 2AlCl_{3(s)}$ $\boxed{\Delta H = -6386.8 \text{ kJ}}$
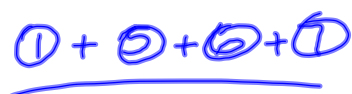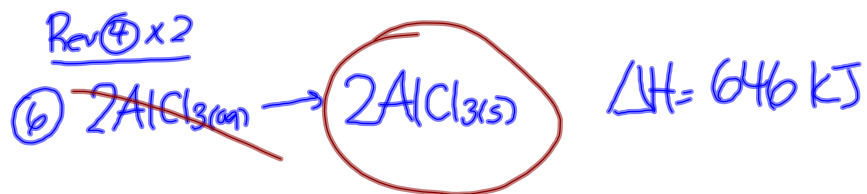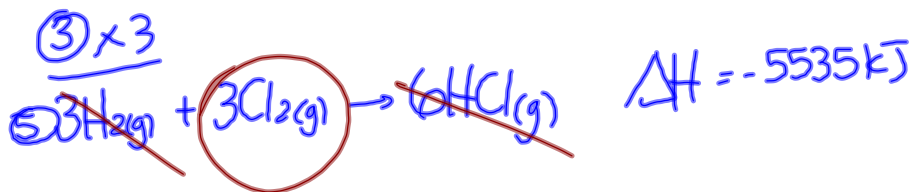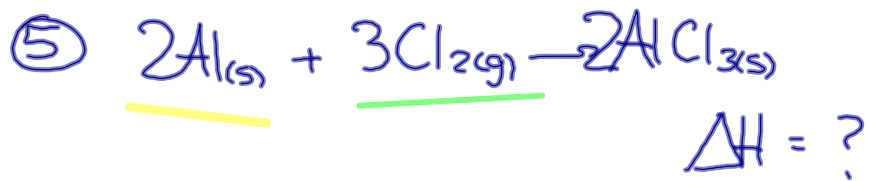
$$3(2)(x-3) = -(4)(1)(x-2)$$
$$6x - 18 = -4x + 8$$
$$10x = 26$$
$$x = \frac{13}{5}$$