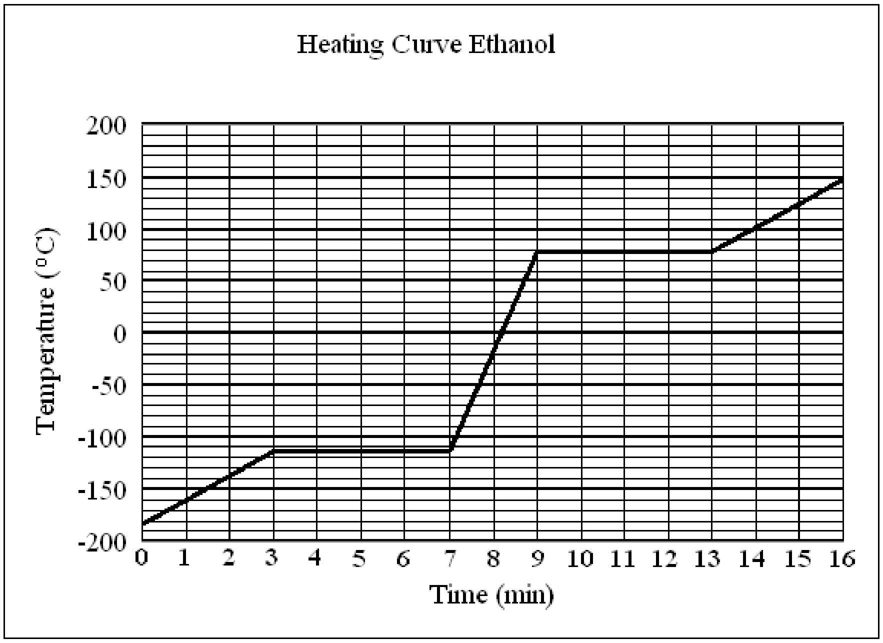
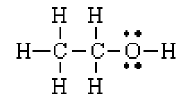
Practice Sheet #51:Problem of the Unit Activity

**Thermochemistry of Ethanol Honors Chemistry** Name: _________________ Per__




Properties of Ethanol:

Formula: $C_2H_5OH$
Structure:



Molar mass: 46.068 g/mol

| State | Specific Heat Capacity (J/g°C) |
|---|---|
| solid | 2.42 |
| liquid | 2.50 |
| gas | 1.80 |

Melting point: –114 °C
Heat of Fusion: 109 J/g
Boiling Point: 78 °C
Heat of Vapourization: 586 J/g
Heat of Formation: –235.2 kJ/mol

(1) Label the heating curve to show the phase(s) present in each region.
Label and state the melting point and boiling point.

Between zero minutes and three minutes, the temperature of the solid ethanol is _______________ which causes the molecules to move _______________. Once the temperature reaches ____ °C, the ethanol begins to _______________. When the ethanol melts, heat energy is used to _______________ some of the hydrogen bonds between molecules. The ethanol is melting between ____ minutes and ____ minutes. Once enough hydrogen bonds have been broken, the ethanol is a liquid. Between seven minutes and nine minutes, the temperature of the liquid ethanol is _______________ which causes the molecules to move _______________. Once the temperature reaches _____ °C, the ethanol begins to _______________. When the ethanol boils, heat energy is used to _______________ hydrogen bonds between molecules. The ethanol is boiling between ____ minutes and ____ minutes. Once all the hydrogen bonds have been broken, the ethanol is a gas. Between fourteen minutes and sixteen minutes, the temperature of the gaseous ethanol is _______________ which causes the molecules to move _______________.

(2) Determine the total amount of energy (in kJ) required to change 50 g of solid ethanol at –180 °C to ethanol vapour at 150 °C. Use the data given above for the five thermochemical calculations needed to complete this problem.

(3) Balance the equation for the combustion of ethanol:

____ $C_2H_5OH$ (l) + ____ $O_2$ (g) → ____ $CO_2$ (g) + ____ $H_2O$ (g)

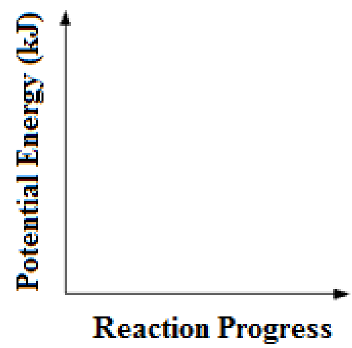
(4) (a) Calculate the heat of reaction from the heats of formation of each chemical.

ΔH = ________________

(b) The reaction is ______thermic.

Add the enthalpy term to the appropriate side of the equation in question 3.

(c) Sketch a potential energy diagram for the reaction on the axes provided.




(5) (a) Complete the following using the calculated value of the heat of reaction:

$$\Delta H = \frac{\_\_\_\_\_\_\_\_\_\_ kJ}{\_\_ mol\, C_2H_5OH, \_\_ mol\, O_2, \_\_ mol\, CO_2, \_\_ mol\, H_2O}$$

(b) Calculate the amount of heat released for reactions involving each of the following quantities:

(i) 0.200 mol $C_2H_5OH$

(ii) 92.0 g $C_2H_5OH$

(iii) 1.20 mol $O_2$

(iv) 8.80 g $CO_2$

(6) Calculate the heat of the reaction from bond energies. Is this value similar to the ΔH value calculated in #4?

(7) Calculate the heat of reaction using Hess' Law.

Steps: C (s) + $O_2$ (g) → $CO_2$ (g) ΔH = –393.5 kJ/mol

$H_2$ (g) + ½ $O_2$ (g) → $H_2O$ (g) ΔH = –242.0 kJ/mol

2C (s) + 3$H_2$ (g) + ½ $O_2$ (g) → $C_2H_5OH$ (l) ΔH = –235.2 kJ/mol

How does this value compare to the value calculated in #4?