Announcements

To join clicker to class today (Clickers with LCD display joins automatically):

- Turn on the Clicker (the red LED comes on).
- Push "Join" button followed by "20" followed by the "Send" button (switches to flashing green LED if successful).

- Even if the weather is nice do not forget to wear appropriate clothing to lab!

- Next exam (exam III) on Thursday.
  - Discussion is review. Bring questions.
  - Please remember to enter through the bottom doors.

Review

- Calorimetry
  - Key relationship: $0 = \Delta H_{RXN} + C\Delta T \Rightarrow \Delta H_{RXN} = -C\Delta T$
- Bond energies to calculate ΔH_{RXN}
  - Breaking bonds requires putting energy in (+) (Don't forget to multiply # bonds in molecule by stoichiometric coefficients)
  - Making bonds releases energy (-) (Remember stoichiometric coefficients)
  - $\Delta H_{RXN} = \Delta H_{break} + \Delta H_{make}$
- ΔH^o_f to calculate ΔH_{RXN}
  - Key relationship: $\Delta H^o_{RXN} = \sum \Delta H^o_f(prod) - \sum \Delta H^o_f(react)$
- Fuel Values: kJ/g calculated from kJ/mol using molar mass (g/mol) to convert.

Fuel Values

Compound	Combustion Eq	Molar ΔH (kJ/mol)	Molar Mass (g)	Fuel Value (kJ/g)
CH_4 (Methane)	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	-802.3	16.04	50.02
C_2H_6 (Ethane)	$2CH_3CH_3(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$	-1428	30.07	47.49
C_2H_6O (Ethanol)	$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$	-1234.8	46.07	26.8
C_8H_{18} (Octane)	$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$	-4678	114.23	40.95
$C_6H_{12}O_6$ (glucose)	$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$	-2537	180.16	14.08
H_2	$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$	-241.8	2.02	120

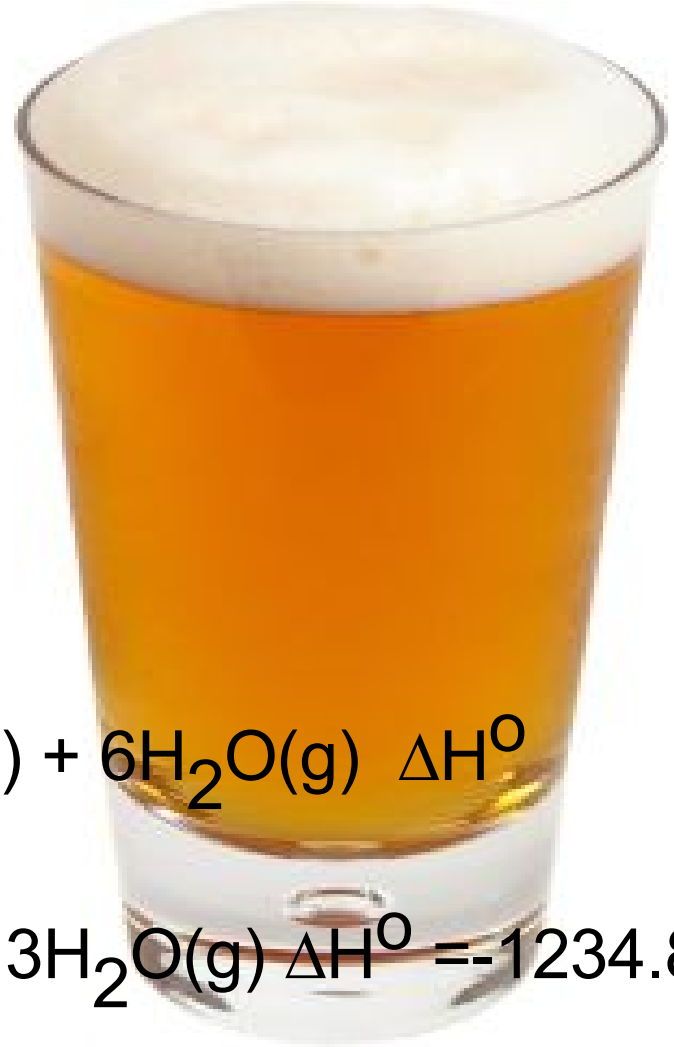
Fuel Values and Volumetric Fuel Values

Compound	Combustion Eq	Molar ΔH (kJ/mol)	Molar Mass (g)	Fuel Value (kJ/g)	Density (g/mL)	kJ/mL
CH_4 (Methane)	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	-802.3	16.04	50.02	0.000656	0.0328
C_2H_6 (Ethane)	$2CH_3CH_3(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$	-1428	30.07	47.49	0.00123	0.0584
C_2H_6O (Ethanol)	$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$	-1234.8	46.07	26.8	0.789	21.1
C_8H_{18} (Octane)	$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$	-4678	114.23	40.95	0.703	28.8
$C_6H_{12}O_6$ (glucose)	$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$	-2537	180.16	14.08	0.780	11.0
H_2	$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$	-241.8	2.02	120	0.0000824	0.00989

Energy per mole CO_2

Compound	Combustion Eq	ΔH (kJ)	Fuel Value (kJ/g)	kJ/mL	kJ/mole CO_2	mole CO_2/kJ
CH_4 (Methane)	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	-802.3	50.02	0.0328	-802	-1.25E-003
C_2H_6 (Ethane)	$2CH_3CH_3(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$	-2856	47.49	0.0584	-714	-1.40E-003
C_2H_6O (Ethanol)	$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$	-1234.8	26.8	21.1	-617	-1.62E-003
C_8H_{18} (Octane)	$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$	-9356	40.95	28.8	-585	-1.71E-003
$C_6H_{12}O_6$ (glucose)	$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$	-2537	14.08	11.0	-423	-2.36E-003
H_2	$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$	-483.6	120	0.00989	---	0.00E+000

Why do bacteria make ethanol from sugar?



Because the anaerobic fermentation reaction produces energy:

$C_6H_{12}O_6(s) \rightarrow 2\ C_2H_6O(l) + 2\ CO_2(g)\ \Delta H^o = ?$

We already know:

$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)\ \Delta H^o = -2537$ kJ

$C_2H_6O(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)\ \Delta H^o = -1234.8$ kJ