Announcements – Lecture XX – Friday, June 21st

FINAL LAB: TUE, JUN 25th, 1:30-4:30

EXAM III: FRIDAY, JUN 28th, IN CLASS
3 OR 4 questions taken FROM:
LAB ONLS, 3.4, 4.2, 4.5, 5.5, 5.6

Quiz 16 Last Name: ______________________________

Write the **net ionic equation** for the reaction that takes placed when aqueous solutions of **lithium hydroxide** and **hydrofluoric acid (HF)** are combined?

$LiOH(aq) + HF(aq)$

$[Li^+, OH^-]$ $[H^+, F^-]$

$LiF(aq)$ $HOH = H_2O(l)$

$LiOH(aq) + HF(aq) = LiF(aq) + H_2O(l)$

$LiOH(aq) + HF(aq) = LiF(aq) + H_2O(l)$

SB WA Salt

$Li^+ + OH^- + HF(aq) = Li^+ + F^- + H_2O(l)$

$OH^- + HF(aq) = F^- + H_2O(l)$

NIE

5.1 Energy

A: Kinetic, Potential, Units and 1st Law of Thermodynamics

Kinetic Energy:

Energy of motion … Thermal, Mechanical, Electromagnetic … etc

$E = \frac{1}{2}mv^2$

Potential Energy:

Positional energy … Chemical, Electrostatic … etc

$E = mgh$

Units of Energy:

$E = mgh$

$kg(m.s^{-2})\,m = kg.m^2.s^{-2} = J$

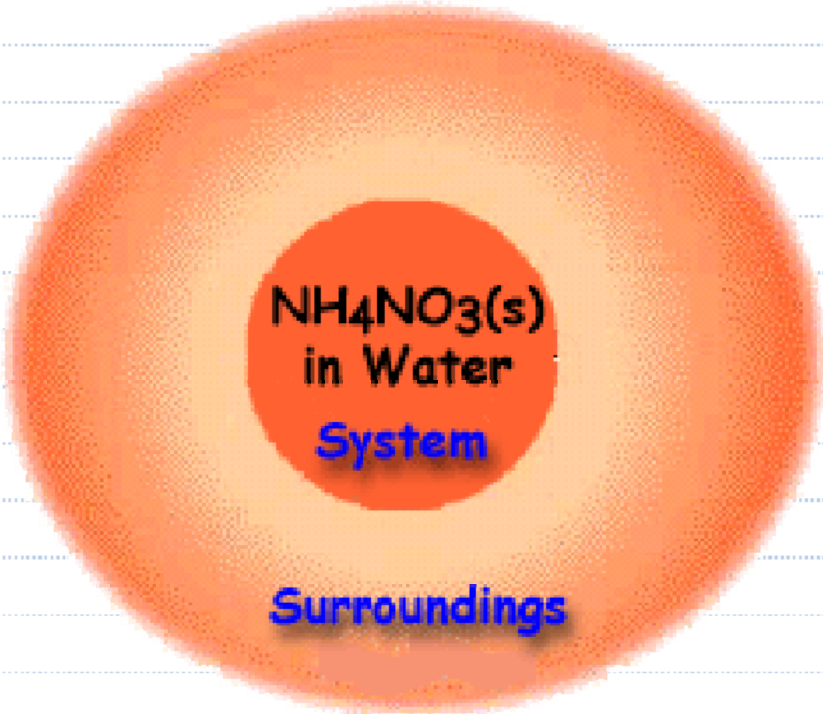
$m = 0.6\,kg$ (~ can of soda)
$h = 1.7\,m$ (~ average shoulder height)

$E = 0.6(9.18)(1.7) \approx 10\,J$

1st Law of Thermodynamics :– Conservation of Energy.

5.1 Energy

C: Principles of Thermodynamics



SYSTEM: What we are concerned with ... the chemical reaction.

SURROUNDINGS: Everything else

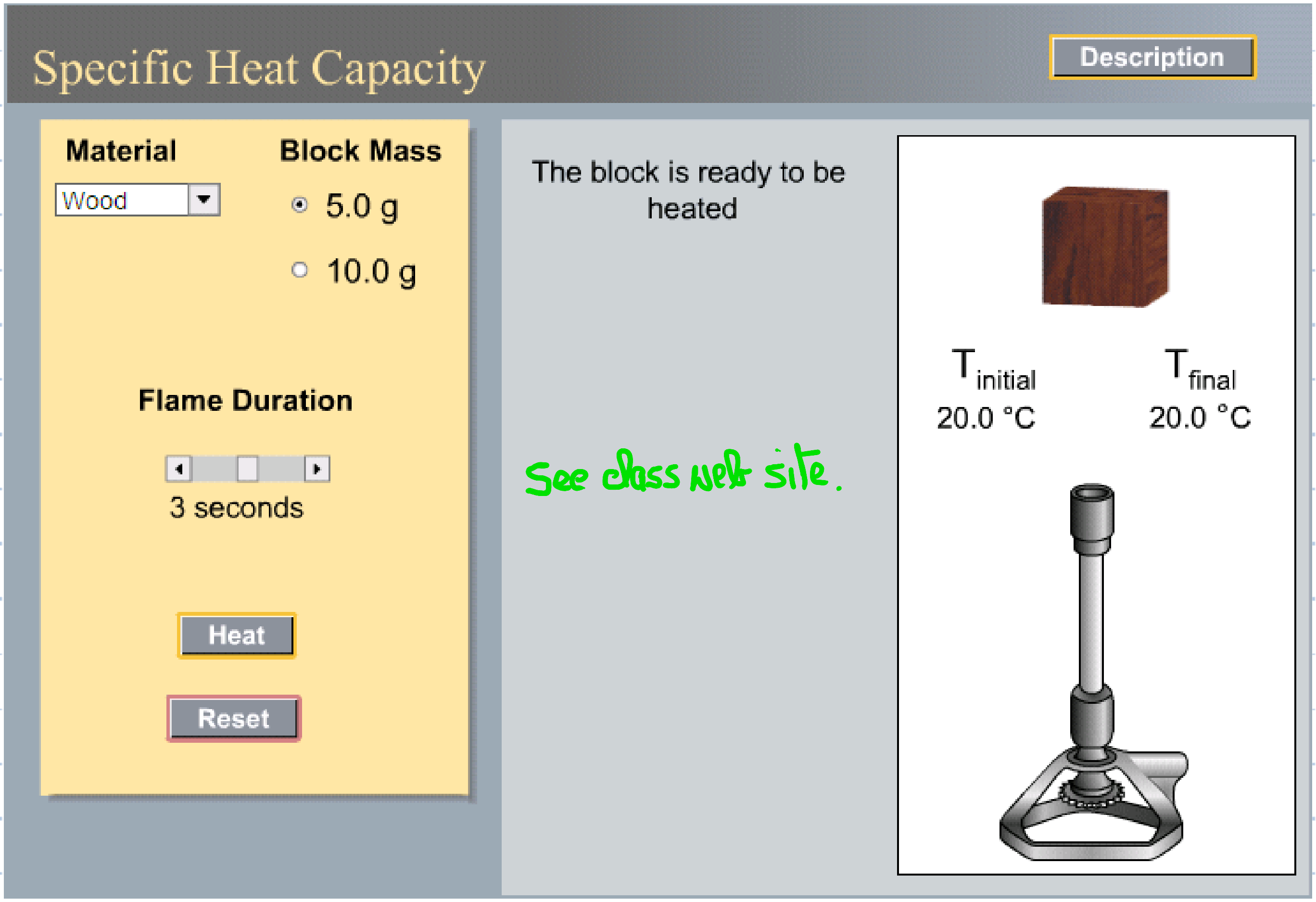
SYSTEM + SURROUNDINGS = UNIVERSE

Exothermic : Heat given off ... $\Delta H < 0$

Endothermic : Heat required ... $\Delta H > 0$

5.3 Energy, Temperature Changes, and Changes in State

A: Heat Transfer and Temperature Changes – Heat Capacity



See class web site.

$$q = m \times C \times \Delta T$$

- m → mass (g)
- C → Heat Capacity
- ΔT → Change in Temperature

$$\Delta T = T_{FINAL} - T_{INITIAL}$$

A: Heat Transfer and Temperature Changes – Heat Capacity

How much energy is required to raise the temperature of 14.5g of gaseous hydrogen from 23.4°C to 35.3°C.
{Heat Capacity H_2 = 14.3J/g°C}

$$q = m \times C \times \Delta T$$

$m = 14.5g$
$C = 14.3\ J/g.°C$
$\Delta T = T_f - T_i = 35.3 - 23.4 = 11.9°C$

$$q = 14.5g\,(14.3\ J/g.°C)\,11.9°C = 2.47 \times 10^3\ J$$

or

$2.47\ kJ$ $(1\ kJ = 1 \times 10^3\ J)$

5.3 Energy, Temperature Changes, and Changes in State

B: Heat Transfer Between Substances

A 35.6g sample of copper at 99.8°C is dropped into a beaker containing 183g of water at 18.5°C. What is the final temperature when thermal equilibrium is reached?

$q_{Cu} = m \times C \times \Delta T$

$q_{H_2O} = m \times C \times \Delta T$

1^{ST} LAW : $\Sigma q\text{'s} = 0$

Cu: 0.385 J/g.°C

H_2O = 4.184 J/g.°C

$q_{Cu} = 35.6(0.385)\Delta T$

$= 13.706\, \Delta T$

$= 13.706\,(T_f - 99.8)$

$= 13.706\, T_f - 1367.9$

$q_{H_2O} = 183(4.184)\,\Delta T$

$= 765.7\,\Delta T$

$= 765.7\,(T_f - 18.5)$

$= 765.7\,T_f - 14{,}165$

$\Sigma q\text{'s} = 0$

$13.706\,T_f - 1367.9 + 765.7\,T_f - 14{,}165 = 0$

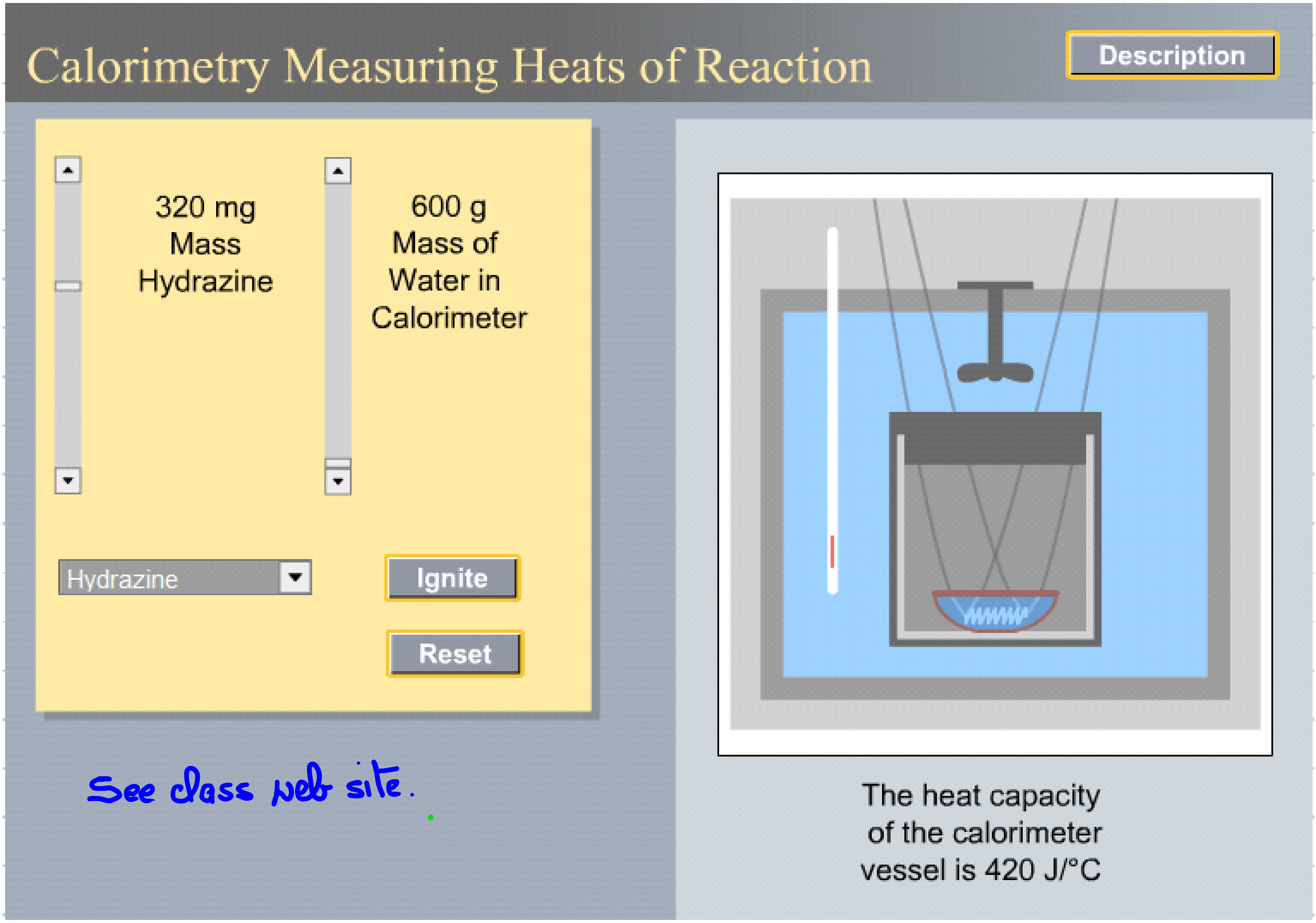
$779.406\,T_f - 15{,}532.9 = 0$

$779.406\,T_f = 15{,}532.9$

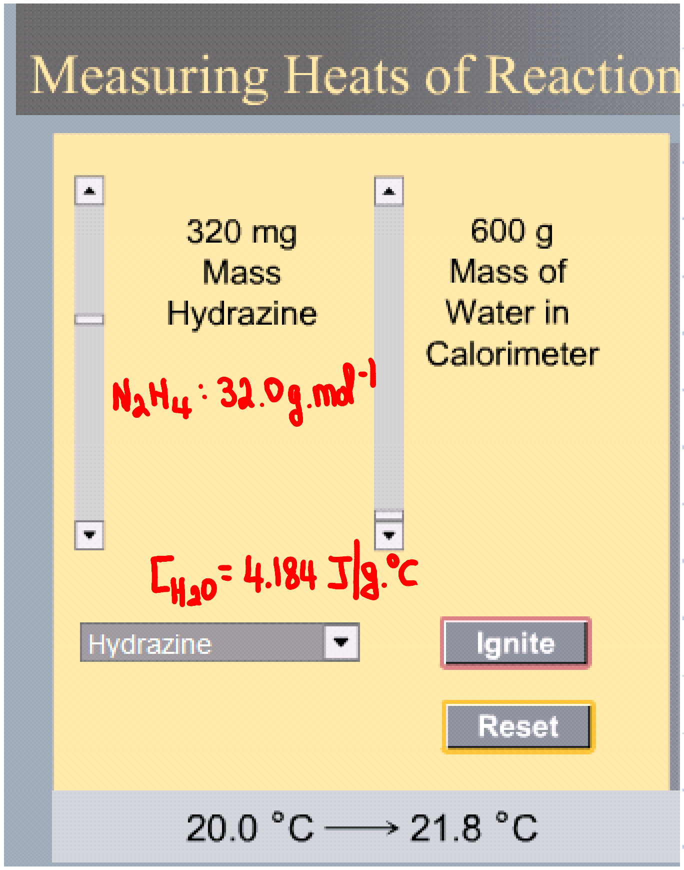
$$T_f = \frac{15{,}532.9}{779.406} = 19.9°C$$

5.4 Enthalpy Changes and Chemical Reactions

C: Determining Enthalpy Change -- Calorimetry



C: Determining Enthalpy Change – Calorimetry – 1st Approximation



$N_2H_4 : 32.0 \, g.mol^{-1}$

$C_{H_2O} = 4.184 \, J/g.°C$

$\Delta T = 21.8 - 20.0 = 1.8°C$

$q_{H_2O} = m \times C \times \Delta T$
$= 600 \times 4.184 \times 1.8 = 4.52 \times 10^3 \, J$

$\Sigma q\text{'s} = 0 : \quad q_{RXN} + q_{H_2O} = 0$
$q_{RXN} = -q_{H_2O}$
$= -4.52 \times 10^3 \, J$

$\dfrac{320 \, mg \;|\; 1 \, g}{\;\;|\; 1000 \, mg} = 0.32 \, g$

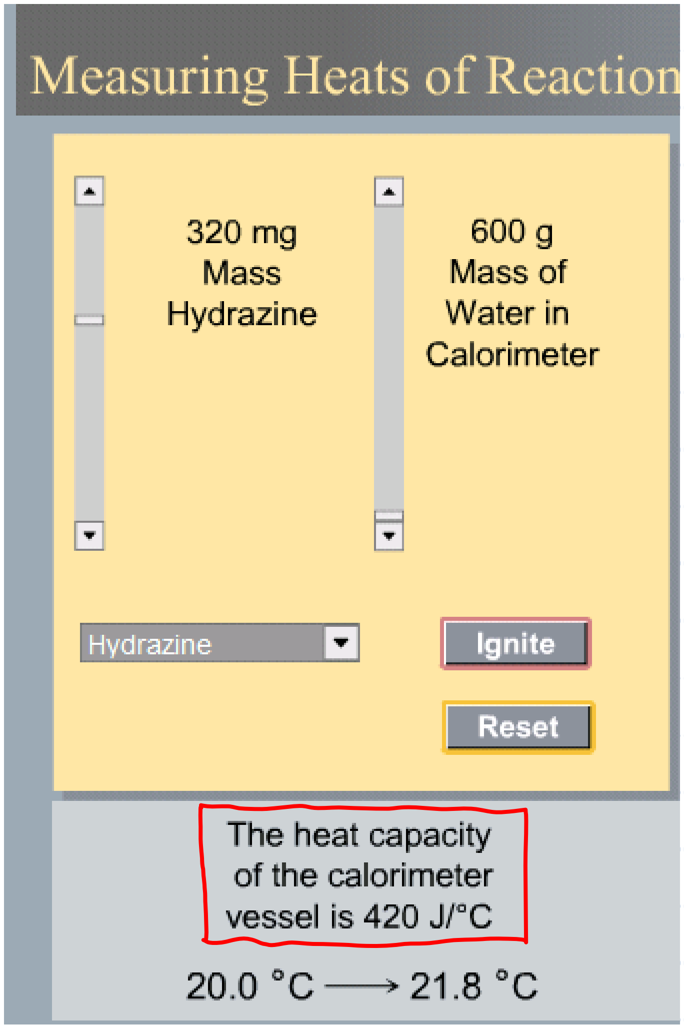
$\dfrac{0.32 \, g \;|\; 1 \, mol}{\;\;|\; 32.0 \, g} = 0.01 \, mol$

$q_{RXN} = \dfrac{-4.52 \times 10^3 \, J}{0.01 \, mol} = -4.52 \times 10^5 \, J.mol^{-1}$

OR

$-452 \, kJ.mol^{-1}$

C: Determining Enthalpy Change – Calorimetry – Modified



$q_{H_2O} = 4.52 \times 10^3\ J$ ... see previous slide

$q_{cal} = m \times C \times \Delta T$

↳ Calorimeter Constant

"Heat capacity of the calorimeter"

$= 420\ J/°C \times 1.8°C = 756\ J$

$\Sigma q's = 0$

$q_{RXN} + q_{H_2O} + q_{cal} = 0$

$q_{RXN} = -(q_{H_2O} + q_{cal})$

$= -(4.52 \times 10^3 + 756)$

$= -5.27 \times 10^3\ J$

$$q_{RXN} = \frac{-5.27 \times 10^3\ J}{0.01\ mol} = -5.27 \times 10^5\ J.mol^{-1}$$

OR

$-527\ kJ.mol^{-1}$

↑ see previous slide