

[TP] Aqueous solutions at the same temperature are combined, a reaction occurs, and the temperature of the combined solutions goes up.
The water is ...

33% 1. the system
33% 2. the surroundings
33% 3. neither system nor surroundings

Response Counter 10

Lecture 22 CH101 A1 (MWF 9:05 am)

Friday, October 27, 2017

For today ...

- System vs. surroundings
- Detecting heat
- Predicting the sign of heat
- Detecting work

Next lecture: Practice with first law; Amount of heat depends on whether there is work

System vs. surroundings

Chemical system, chemical surroundings

In chemical reactions, energy change is due to bond breaking and bond making as reactants become products.

The “system” is the collection of reactants and products.

The “surroundings” is everything else.

Chemical system, chemical surroundings

In aqueous reactions, the containing water is part of the surroundings.

Heat released by the "system" warms the solution.

Heat absorbed by the "system" cools the solution.

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Response Counter 10

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[TP] Aqueous solutions at the same temperature are combined, a reaction occurs, and the temperature of the combined solutions goes up.
The reactants are ...

25% 1. the system
25% 2. the surroundings
25% 3. part of the system
25% 4. part of the surroundings

Response Counter 10

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[Quiz] Acetic acid dissolves in water as a weak electrolyte,

$$CH_3COOH(aq) + H_2O(l) \leftrightarrows H_3O^+(aq) + CH_3COO^-(aq)$$

In the acetic acid solution, the acetate ion, $CH_3COO^-(aq)$, is ...

25% 1. the system
25% 2. the surroundings
25% 3. part of the system
25% 4. part of the surroundings

Response Counter 10

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Detecting heat

How do we know heat is present?

Since $q_{surr} = m\, c\, \Delta T_{surr}$ ...
we can use temperature change of surroundings to monitor heat flow.

Temperature increase in surroundings, $\Delta T_{surr} > 0$, means ...
energy flow out of system into surroundings ...
energy of system goes down ...
and so, $q < 0$.

How do we know heat is present?

Since $q_{surr} = m\, c\, \Delta T_{surr}$ ...
we can use temperature change of surroundings to monitor heat flow.

Temperature decrease in surroundings, $\Delta T_{surr} < 0$ means ...
energy flow from surroundings into system ...
energy of system goes up ...
and so, $q > 0$.

For chemical processes, T_{sys} does not change

For A—A $\rightleftharpoons$ 2 A, energy is required to break the bonds

Energy comes from surroundings and so T_{sur} goes down

Since this energy is used to break the bonds, T_{sys} does not change

[TP] When $NaHCO_3(s)$ is dissolved in 200 mL of $HCl(aq)$, the temperature of the solution goes down. This means the chemical reaction between the $NaHCO_3(s)$ and the $HCl(aq)$ results in the chemical system …

25% 1. giving off heat and so $q > 0$
25% 2. giving off heat and so $q < 0$
25% 3. absorbing heat and so $q < 0$
25% 4. absorbing heat and so $q > 0$

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[TP] Is

$$2\ \mathrm{A{-}B} \rightleftharpoons 2\ \mathrm{A} + 2\ \mathrm{B}$$

endothermic ($q > 0$) or exothermic ($q < 0$)?

33% 1. Endothermic
33% 2. Exothermic
33% 3. Further information needed

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[TP] Is

$$2\ \mathrm{A} \rightleftharpoons \mathrm{A{-}A}$$

endothermic ($q > 0$) or exothermic ($q < 0$)?

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33% 1. Endothermic
33% 2. Exothermic
33% 3. Further information needed

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Reactants are only part of the system

In general, energy changes in chemical reactions are due to both bond breaking and bond breaking.

2 A–B ⇌ 2 A + 2 B

is endothermic, since breaking bonds always requires energy

2 A ⇌ A–A and 2 B ⇌ B–B

are each exothermic, since making bonds always releases energy

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Reactants are only part of the system

We cannot know whether

2 A–B ⇌ A–A + B–B

is endothermic ($q > 0$) or exothermic ($q < 0$) ...

without knowing whether the energy need for bond breaking

2 A–B ⇌ 2 A + 2 B

is larger or smaller than the energy release of bond making

2 A ⇌ A–A and 2 B ⇌ B–B

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Reactants are only part of the system

To know the sign of q we must always consider both reactants and products, and for this reason, in chemical reactions, the system consists of both the reactants and products.

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[Quiz] Consider the reaction $2\ H_2O(l) + 3\ CH_4(g) + CO_2(g) \rightleftharpoons 4\ CH_3OH(l)$. This reaction must ...

20%	1.	give off heat and so $q > 0$
20%	2.	give off heat and so $q < 0$
20%	3.	absorb heat and so $q < 0$
20%	4.	absorb heat and so $q > 0$
20%	5.	Further information needed

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Reactants are only part of the system

To know the sign of q we must always consider both reactants and products. For the reaction

$2\ H_2O(l) + 3\ CH_4(g) + CO_2(g) \rightleftharpoons 4\ CH_3OH(l)$

It turns out that

$q = +236.2$ kJ

That is, the cost of bond breaking in the reactants exceeds the gain of bond making in the products.

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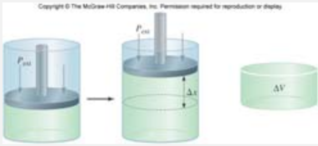
How do we know if work is present?

Macroscopic movement, for example a piston.



Work done by gas: force × distance = $(F\ /\ A) \times (\Delta x\ A) = P_{ext}\ \Delta V$

Work done on gas: $w = -P_{ext}\ \Delta V$

Expansion of gas pushes against P_{ext}, gas expends energy, $w < 0$

Compression of gas pushed on by P_{ext}, gas gains energy, $w > 0$

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[TP] Consider the reaction $2\ H_2O(l) + 3\ CH_4(g) + CO_2(g) \rightleftharpoons 4\ CH_3OH(l)$. This chemical system must be …

20% 1. doing work and so $w > 0$
20% 2. doing work and so $w < 0$
20% 3. having work done on it and so $w > 0$
20% 4. having work done on it and so $w < 0$
20% 5. Further information needed

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[Quiz] When $NaHCO_3(s)$ is dissolved in 200 mL of $HCl(aq)$, $CO_2(g)$ bubbles form. This means the chemical reaction between the $NaHCO_3(s)$ and the $HCl(aq)$ must be …

20% 1. doing work and so $w > 0$
20% 2. doing work and so $w < 0$
20% 3. having work done on it and so $w > 0$
20% 4. having work done on it and so $w < 0$
20% 5. Further information needed

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