

[TP] In a certain chemical reaction, 10 kJ of heat flow into the system and the system does 21 kJ of work on the surroundings. This means ΔU = ...

13% 1. +31 kJ
13% 2. +21 kJ
13% 3. +11 kJ
13% 4. +10 kJ
13% 5. −10 kJ
13% 6. −11 kJ
13% 7. −21 kJ
13% 8. −31 kJ

Lecture 22 CH101 A1 (MWF 9 am)

Friday, October 28, 2016

Begin ch7: Chemical reactions and energy flows
- First law of thermodynamics
- System vs. surroundings
- Detecting heat and work

Next lecture: Amount of heat depends on whether there is work

Ch 7: Chemical Reactions and Energy Flows

First law of thermodynamics

Energy, U, is exchanged between system and surroundings as heat, q, and work, w,

$\Delta U = q + w$

Positive values increase energy of system

$\Delta U = q + w$

q = heat flow into the system

w = done on the system

First law of thermodynamics

In a certain chemical reaction, 10 kJ of heat flow into the system and the system does 21 kJ of work on the surroundings. Sketch the energy diagram showing q, w, and ΔU for this reaction. Indicate the initial and final energy by horizontal lines labeled U_i and U_f, respectively.

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System vs. surroundings

Chemical system, chemical surroundings

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

Chemical system, chemical surroundings

In 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.

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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[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

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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

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Reactants are only part of the system

Is

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

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

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Reactants are only part of the system

Is

2 A–B ⇌ A–A + B–B

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

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 tell 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

That is, 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] 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

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Detecting heat and work

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How do we know heat is present?

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

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

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How do we know heat is present?

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

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

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For chemical processes, T_{sys} does not change

For A—A ⇌ 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

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[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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