مراجعة القسم الثالث Thermochemical من وحدة Energy and Chemical Change الكيميائية والتغيرات الطاقة

تاريخ إضافة الملف على موقع المناهج: 2024-09-21 18:44:06

إعداد: SCHOOL ALFAROUQ

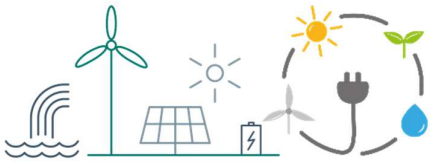
المزيد من الملفات بحسب الصف الثاني عشر المتقدم والمادة كيمياء في الفصل الأول

1	مراجعة القسم الثاني Heat الحرارة من وحدة Energy and Chemical Change الكيميائية والتغيرات الطاقة
2	مراجعة القسم الأول Energy الطاقة من وحدة Energy and Chemical Change الكيميائية والتغيرات الطاقة

المزيد من الملفات بحسب الصف الثاني عشر المتقدم والمادة كيمياء في الفصل الأول	
3	مذكرة الوحدة الأولى الطاقة والتغيرات الكيميائية أسئلة الاختبارات الوزارية السابقة
4	تدريبات على الوحدة الأولى الطاقة والتغيرات الكيميائية
5	عرض بوربوينت الوحدة الأولى الطاقة والتغيرات الكيميائية

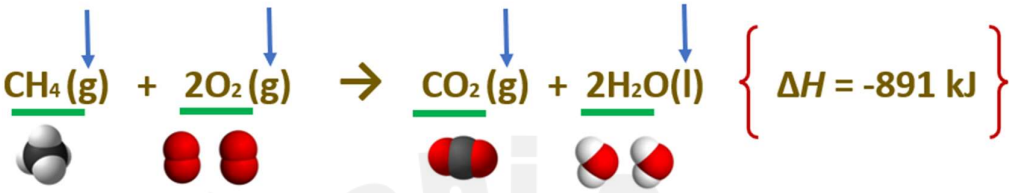
Chapter: Energy & Chemical Change

Section (3): Thermochemical Equations



THERMOCHEMICAL EQUATION:

It is a balanced chemical equation that includes the physical states of all reactants and products, and the energy change, usually expressed as the change in enthalpy (ΔH).



Examples

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H = -1625 \text{ kJ}$$

$$NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq) \quad \Delta H = 27 \text{ kJ}$$

Exercise

(Q) Which of the following correctly represent these reactions?

1. 1625 kJ of heat is released to the surroundings in the reaction between Fe and O_2 to form Fe_2O_3

a. $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H_{rxn} = +1625$ kJ
b. $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H_{rxn} = -1625$ kJ
c. $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) + 1625$ kJ
d. $4Fe(s) + 3O_2(g) + 1625$ kJ $\rightarrow 2Fe_2O_3(s)$

2. 27 kJ of heat is absorbed from the surroundings in the process of dissolving NH_4NO_3.

a) $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq) \quad \Delta H_{rxn} = 27$ kJ
b) $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq) \quad \Delta H_{rxn} = -27$ kJ
c) $NH_4NO_3(s) + 27$ kJ $\rightarrow NH_4^+(aq) + NO_3^-(aq)$
d) $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq) + 27$ kJ

MOLAR ENTHALPY (HEAT) OF COMBUSTION (ΔH°_{comb})

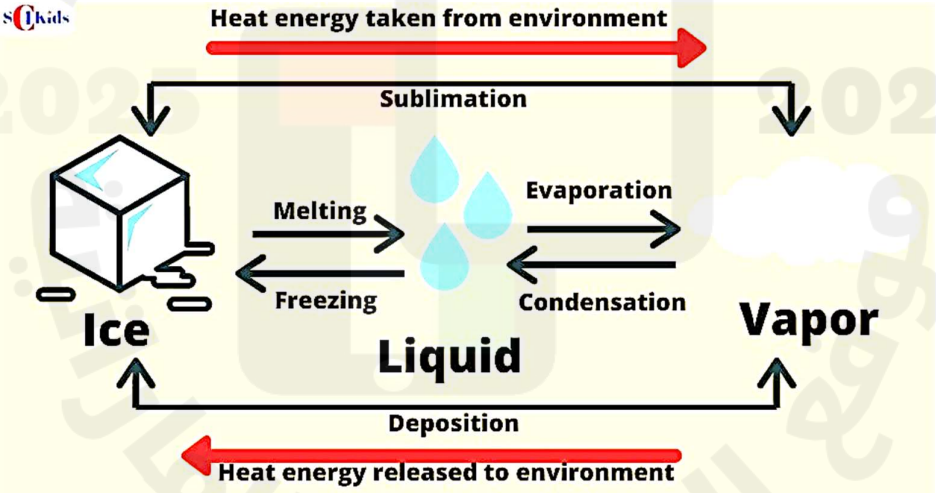
It is the enthalpy change for the **complete burning of one mole** of the substance.

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \quad \Delta H_{comb} = -2808\ kJ$$

(Table 1)

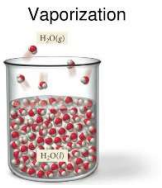
Substance	Formula	ΔH°_{comb} (kJ/mol)
Sucrose (table sugar)	$C_{12}H_{22}O_{11}(s)$	−5644
Octane (a component of gasoline)	$C_8H_{18}(l)$	−5471
Glucose (a simple sugar found in fruit)	$C_6H_{12}O_6(s)$	−2808
Propane (a gaseous fuel)	$C_3H_8(g)$	−2219
Methane (a gaseous fuel)	$CH_4(g)$	−891

Standard state conditions : 298 K (25°C) , 1 atm pressure



Molar enthalpy (heat) of vaporization (ΔH_{vap}).

The heat required to vaporize one mole of a liquid.



Molar enthalpy (heat) of fusion (ΔH_{fus}).

The heat required to melt one mole of a solid substance

- **Vaporization & fusion (melting)** absorbs heat.
- **Condensation & freezing** releases heat.

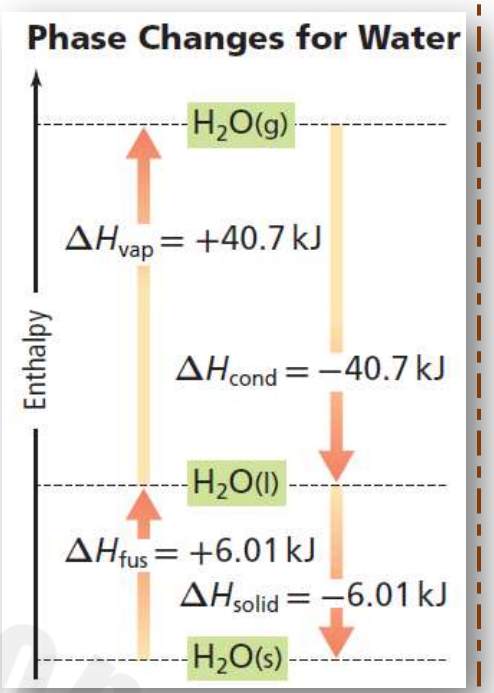


Table 4 Standard Enthalpies of Vaporization and Fusion

Substance	Formula	ΔH°_{vap} (kJ/mol)	ΔH°_{fus} (kJ/mol)
Water	H_2O	40.7	6.01
Ethanol	C_2H_5OH	38.6	4.94
Methanol	CH_3OH	35.2	3.22
Acetic acid	CH_3COOH	23.4	11.7
Ammonia	NH_3	23.3	5.66

$$\Delta H_{vap} = -\Delta H_{cond}$$
$$\Delta H_{fus} = -\Delta H_{solid}$$

Examples.

$H_2O(l) \rightarrow H_2O(g)$ $\quad \Delta H_{vap} = 40.7$ kJ

$H_2O(s) \rightarrow H_2O(l)$ $\quad \Delta H_{fus} = 6.01$ kJ

$H_2O(g) \rightarrow H_2O(l)$ $\quad \Delta H_{cond} = -40.7$ kJ

$H_2O(l) \rightarrow H_2O(s)$ $\quad \Delta H_{solid} = -6.01$ kJ

Exercises

(1) Calculate the heat required to melt 25.7 g of solid methanol at its melting point. (ΔH_{fus} of solid methanol = 3.22 kJ/mol)

_____

(2) How much heat evolves when 275 g of ammonia gas condenses to a liquid at its boiling point? (ΔH_{cond} of ammonia = -23.3 kJ/mol)

_____

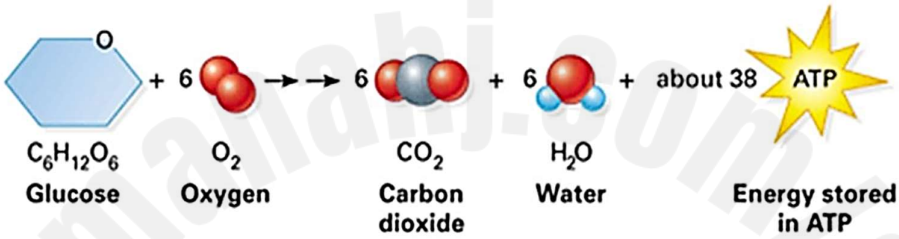
(3) What mass of methane (CH_4) must be burned in order to liberate (release) 12,880 kJ of heat? (ΔH°_{comb} of methane = -891 kJ/mol).

_____

COMBUSTION REACTIONS

Any hydrocarbon burns in presence of oxygen to produce water vapor & carbon dioxide. (Complete Combustion).

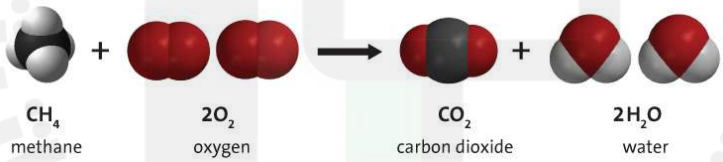
(1) Combustion of glucose inside cells to produce energy (ATP).



The energy released is stored as chemical potential energy in the bonds of molecules of adenosine triphosphate (ATP).

(2) Combustion (burning) of methane gas (CH_4).

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO2\,(g) + 2H_2O(l) + 891\ kJ$$



(3) Combustion of gasoline (Octane) (C_8H_{18}).

$$C_8H_{18}\,(l) + 25/2\ O_2\,(g) \rightarrow 8\ CO_2\,(g) + 9\ H_2O(l) + 5471\ kJ$$

(4) Combustion of Hydrogen gas to produce water molecules

$$H_2\,(g) + \mathbf{1/2}\ O_2\,(g) \rightarrow H_2O\,(l) + 286\ kJ$$

The combustion of hydrogen provides the energy to lift a space shuttle into the outer space.

EXERCISES

(1) How much heat is evolved when 54.0 g glucose ($C_6H_{12}O_6$) is burned according to this equation? $C_6H_{12}O_6\,(s) + 6\,O_2\,(g) \rightarrow 6CO_2\,(g) + 6\,H_2O\,(l)$ $\Delta H_{comb} = -2808$ kJ

(2) How much heat is absorbed when 45.00 g of $C_{(s)}$ reacts in the presence of excess SO_2 (g) to produce CS_2(l) and CO(g) according to the following chemical equation? $5\,C(s) + 2\,SO_2(g) \rightarrow CS_2(l) + 4\,CO\,(g)$ $\Delta H° = 239.9$ kJ/mol

(3) Write a complete thermochemical equation for the combustion of ethanol (C_2H_5OH). $\Delta H_{comb} = -1367$ kJ/mol.

(4) Determine Which of the following processes are exothermic & Endothermic?

a. $C_2H_5OH(l) \rightarrow C_2H_5OH(g)$

b. $Br_2(l) \rightarrow Br_2(s)$

c. $C_5H_{12}(g) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$

d. $NH_3(g) \rightarrow NH_3(l)$

e. $NaCl(s) \rightarrow NaCl(l)$

(5) Explain how you could calculate the heat released in freezing 0.250 mol water. (*Refer to the tables in the previous pages if required*).

(6) How much heat is released by the combustion of 206 g of hydrogen gas?

$\Delta H_{comb} = -286$ kJ/mol

(7) The molar heat of vaporization of ammonia is 23.3 kJ/mol. What is the molar heat of condensation of ammonia?

(8) The reaction A → C is shown in the enthalpy diagram.
Is the reaction exothermic or endothermic?
Explain your answer.