



وزارة التربية والتعليم
Ministry of Education

Chemistry
Department

2025-2026



Trimester 1

Chemistry

HAMZA BIN ABDULMUTILIB SCHOOL

G12 ADV

C101

FINAL REVISION

TERM 1

EOT COVERAGE

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How much energy in joules is supplied by a breakfast containing 170 Cal?

ما مقدار الطاقة بوحدة الجول (J) التي تزودنا بها وجبة افطار تحوي 170 Cal؟

170 J

☐

$7.11 \times 10^5 \text{ J}$

☐

$1.7 \times 10^5 \text{ J}$

☐

711 J

☐

Which of the following statements is true about the two figures in the table below?

أي العبارات التالية صحيحة فيما يتعلق بالشكلين في الجدول أدناه؟

	
150 Cal	$5.0 \times 10^5 \text{ J}$
Y	X

The energy in X is greater than in Y

الطاقة في X أكبر منها في Y

The energy in Y is $3.6 \times 10^5 \text{ J}$

الطاقة في Y تساوي $3.6 \times 10^5 \text{ J}$

The energy in X is 355 Cal

الطاقة في X تساوي 355 Cal

The energy in Y is greater than in X

الطاقة في Y أكبر منها في X

Which of the following contains **the highest**
nutritional Calories?

أي مما يلي يحتوي على أكبر كمية من السعرات الغذائية Cal؟

Learning Outcomes Covered

- CHM.5.5.01.001

a.

10 Cal

b.

9600 J

c.

86.5 kJ

d.

1000 cal

A 355 g sample of unknown substance was heated from 22.4 °C to 43.6 °C the substance piece absorbs 6.75 kJ of energy.

Using the table below, which is the substance?

Substance	الذهب Gold	الفضة Silver	الألمنيوم Aluminum	الحديد Iron
Specific heat	0.129	0.235	0.897	0.449

- a. Iron الحديد
- b. Aluminum الألمنيوم
- c. Silver الفضة
- d. Gold الذهب

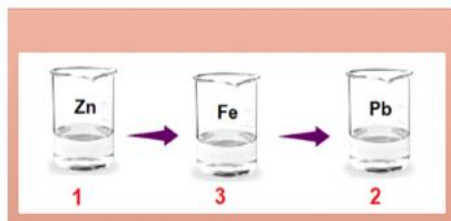
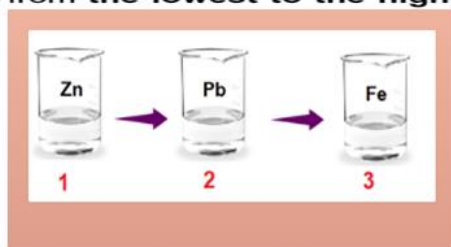
The following table shows specific heat of three metals:

Metal	الفلز	Fe	Pb	Zn
specific heat	الحرارة النوعية	0.449 J/(g.°C)	0.129 J/(g.°C)	0.388 J/(g.°C)

If **1.00 g** of each metal is heated to **100°C** and added to **10.0 g** of H₂O at **25°C** in the three separate glass beakers as in the figure below,



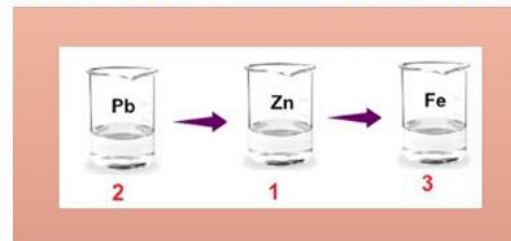
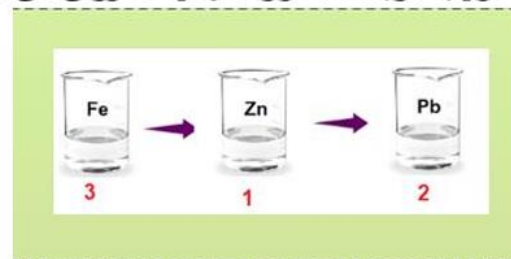
what is the order of the final temperatures of beakers from **the lowest to the highest**?



الجدول التالي يوضح الحرارة النوعية لثلاثة فلزات:

إذا سُخن **1.00 g** من كل فلز إلى **100°C** وأضيف إلى **10.0 g** من H₂O عند **25°C** في ثلاثة كؤوس زجاجية كما في الشكل أدناه،

ما ترتيب درجات الحرارة النهائية للكؤوس من الأقل إلى الأعلى؟



Equal masses of the four metals given in the table below were left to sit in the Sun at the same time and for the same length of time. What is the order of the four metals according to its temperature increase from smallest increase to largest?

متساوية من الفلزات الأربعة الواردة في الجدول أدناه في نفس الوقت ولنفس الفترة الزمنية. ما ترتيب الفلزات لزيادة درجة حرارتها من الأقل إلى الأعلى؟

الفلز Metal	المغنيسيوم Magnesium	الرصاص Lead	السترونشيوم Strontium	الكالسيوم Calcium
الحرارة النوعية Specific Heat	1.023	0.129	0.301	0.647
J / (g.°C)				

Learning Outcomes Covered

- CHM.5.5.01.008

a.

The lowest is calcium, then magnesium, then lead, then strontium

الأقل هو الكالسيوم ثم المغنيسيوم ثم الرصاص ثم السترونشيوم

b.

The lowest is calcium, then strontium, then magnesium, then lead

الأقل هو الكالسيوم ثم السترونشيوم ثم المغنيسيوم ثم الرصاص

c.

The lowest is magnesium, then calcium, then strontium, then lead

الأقل هو المغنيسيوم ثم الكالسيوم ثم السترونشيوم ثم الرصاص

d.

The lowest is lead, then strontium, then magnesium,

الأقل هو الرصاص ثم السترونشيوم ثم المغنيسيوم ثم الكالسيوم

2

CHM.5.5.01.002.02 Calculate the amount of heat released by a substance as its temperature changes

Textbook + Example problem2 + Practice problems

4

CHM.5.5.01.002.03 Calculate the specific heat capacity of a sample given its mass and temperature change

Textbook + Example problem 3 + Practice problems

When a 360 g piece of hot alloy is placed in 425 g of cold water in a calorimeter, the temperature of the alloy decreases by 205°C , while the temperature of the water increases by 18.7°C .

What is the specific heat of the alloy?

Specific heat of water= $4.184 \text{ (J/g}^{\circ}\text{C)}$

a.

 $0.129 \text{ J/(g}^{\circ}\text{C)}$

b.

 $0.235 \text{ J/(g}^{\circ}\text{C)}$

c.

 $0.380 \text{ J/(g}^{\circ}\text{C)}$

d.

 $0.450 \text{ J/(g}^{\circ}\text{C)}$

time. What is the mass of the piece of iron (g) whose temperature increases by the same amount as the piece of aluminum?

الحديد Iron	الألمنيوم Aluminium	المادة Substance
.....	47.0 g	الكتلة Mass
0.449	0.897	الحرارة النوعية Specific Heat J/(g. °C)
30.0° C	30.0° C	ΔT

a.

93.9

b.

45.6

c.

35.5

d.

53.5

If 250 g of ethanol at 75.0°C loses 4655 J of heat, what is the final temperature of ethanol?

(Specific Heat of ethanol = 2.44 J/ (g. °C)

250 من الإيثانول درجة حرارته 75.0°C كمية من الحرارة
4655 J . فما درجة الحرارة النهائية للإيثانول؟
النوعية للإيثانول هي (2.44 J/ (g. °C)

Learning Outcomes Covered

o CHM.5.5.01.008

a.

82.6°C

b.

67.4°C

c.

59.5°C

d.

45.8°C

A 15.0 g piece of cadmium metal absorbed 32.0 cal

of heat. The final temperature was 62.7°C and the specific heat of cadmium equals 0.231 J/(g.°C).

What was the initial temperature?

امتصت قطعة كتلتها 15.0 g من فلز الكاديوم 32.0 cal من الحرارة.

كانت درجة الحرارة النهائية 62.7°C والحرارة النوعية للكاديوم تساوي 0.231 J/(g.°C).

ماذا كانت درجة الحرارة الابتدائية؟

38.7°C

24.1°C

9.3°C

53.4°C

Because you are interested in the heat given off by the chemical reaction going on inside the pack, it is convenient to think of the pack and its contents as the **system**. In thermochemistry, the system is the specific part of the universe that contains the reaction or process you wish to study. Everything in the universe other than the system is considered the **surroundings**. Therefore, the **universe** is defined as the system plus the surroundings.

$$\text{universe} = \text{system} + \text{surroundings}$$

What kind of energy transfer occurs during the exothermic heat-pack reaction? Heat produced by the reaction flows from the heat pack (the system) to your cold hands (part of the surroundings).

What happens in an endothermic reaction or process? The flow of heat is reversed. Heat flows from the surroundings to the system. When barium hydroxide and ammonium thiocyanate crystals, shown in **Figure 7**, are placed in a beaker and mixed, a highly endothermic reaction occurs. Placing the beaker on a wet board allows heat to flow from the water and board (the surroundings) into the beaker (the system). The temperature change is great enough that the beaker freezes to the board.

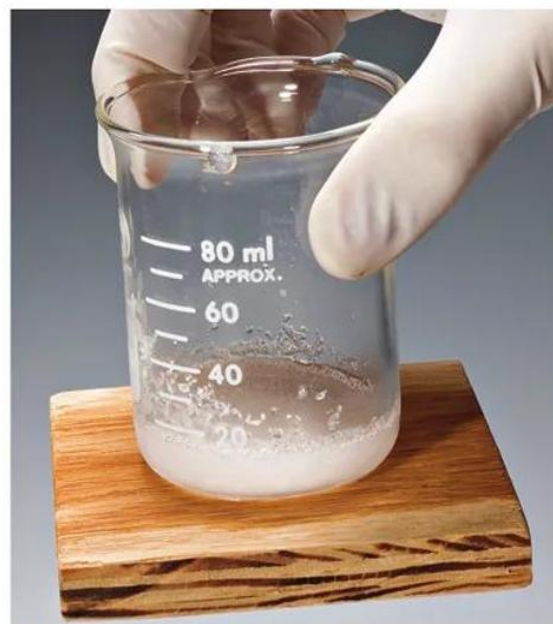


Figure 7 In this endothermic reaction, the reacting mixture draws enough energy from the water and the wet board to cause the wet board to freeze to the beaker.

According to the principles of thermochemistry described, the **universe** is defined as the combination of:

- A. The reaction or process being studied only.
- B. The system plus the contents of the heat pack.
- C. The system plus the surroundings.
- D. Everything that is *not* considered the surroundings.

In the endothermic reaction shown below,
What is the heat flows direction?

في التفاعل الماص للحرارة الموضح أدناه،
ما اتجاه انتقال الحرارة؟

خليط من هيدروكسيد الباريوم وبلورات ثيوسيانات الأمونيوم
a mixture of barium hydroxide and ammonium thiocyanate crystals

لوح رطب
a wet board



Learning Outcomes Covered

- CHM.5.5.01.004

a.

From the beaker to the wet board and water

من الكأس إلى اللوح الرطب والماء

b.

From the mixture to the universe

من الخليط إلى الكون

c.

From the wet board and water to the beaker

من اللوح الرطب والماء إلى الكأس

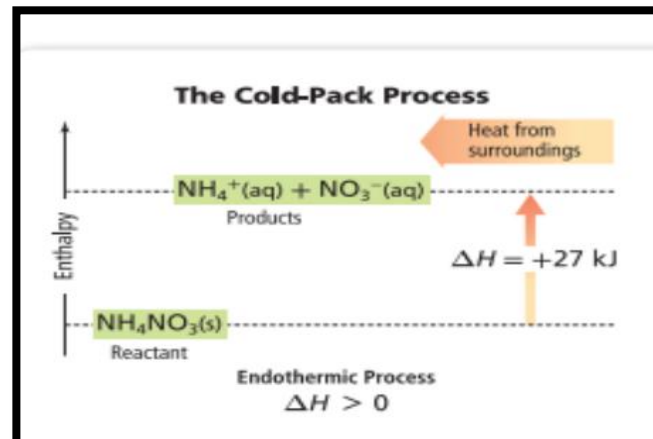
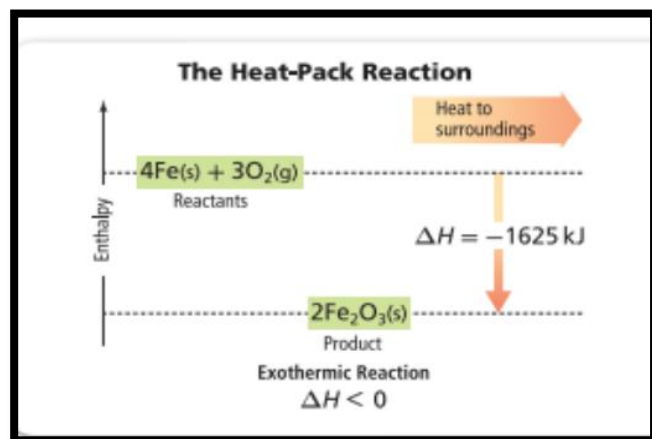
d.

From the system to the surroundings

من النظام إلى المحيط

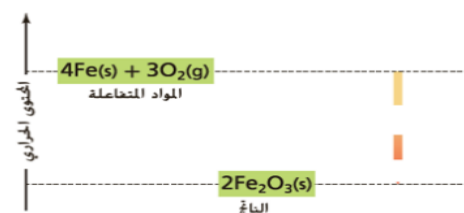
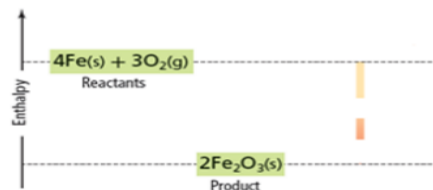
In the highly endothermic reaction described (barium hydroxide and ammonium thiocyanate crystals), the heat flow causes the wet board (part of the surroundings) to freeze to the beaker (the system). This indicates that, for this endothermic process:

A. The surroundings are gaining heat from the system. B. The system is releasing heat into the surroundings. C. The temperature of the system is increasing significantly. D. The system is absorbing heat *from* the surroundings.



Which of the following is true regarding the figure below?

أي مما يأتي صحيح فيما يتعلق بالشكل أدناه؟



The sign of enthalpy change is positive

إشارة التغير في المحتوى الحراري موجبة

This reaction is used in the Cold-Pack

يُستخدم هذا التفاعل في الكمادة الباردة

The reaction is endothermic

التفاعل ماص للحرارة

This reaction is used in the Heat-Pack

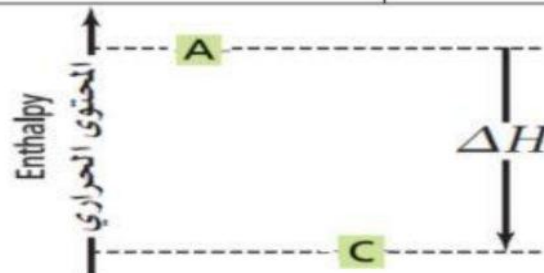
يُستخدم هذا التفاعل في الكمادة الساخنة

Which of the following is **correct** about the reaction with the equation: $A \rightarrow C$, shown in the diagram below?

I.	$\Delta H > 0$
II.	$H_{\text{products}} < H_{\text{reactants}}$
III.	Heat flows from the system to the surroundings

أي من التالية **صحيحاً** حول التفاعل ذو المعادلة: $A \rightarrow C$ الموضَّح بالشكل أدناه؟

I.	$\Delta H > 0$
II.	$H_{\text{المنتجات}} < H_{\text{التواتج}}$
III.	الحرارة تنتقل من النظام إلى المحيط



- A. I only
B. I and II only
C. II and III only
D. I and III only

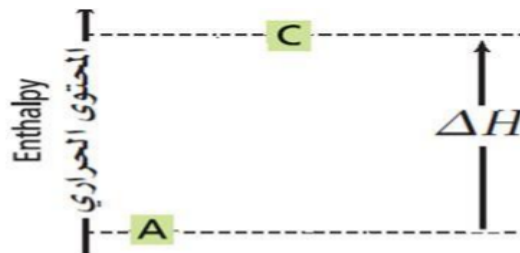
- A. فقط I
B. I و II فقط
C. II و III فقط
D. I و III فقط

Which of the following is **correct** about the reaction with the equation: $A \rightarrow C$, shown in the diagram below?

I.	$\Delta H > 0$
II.	$H_{\text{products}} < H_{\text{reactants}}$
III.	Heat flows from the surroundings to the system

أي من التالية **صحيحاً** حول التفاعل ذو المعادلة: $A \rightarrow C$ الموضَّح بالشكل أدناه؟

I.	$\Delta H > 0$
II.	$H_{\text{المنتجات}} < H_{\text{التواتج}}$
III.	الحرارة تنتقل من المحيط إلى النظام



- A. I only
B. I and III only
C. II and III only
D. I and II only

- A. فقط I
B. I و III فقط
C. II و III فقط
D. I و II فقط

أي التالية **صحيح** فيما يتعلق بالشكل أدناه؟

Which of the following is **correct** regarding the figure below?



The reaction is an exothermic

التفاعل طارد للحرارة

Heat to surroundings

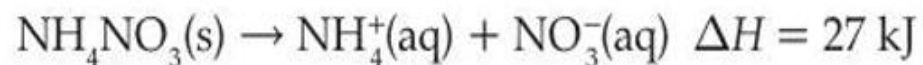
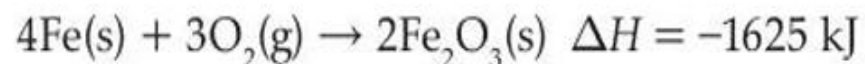
الحرارة إلى الوسط

Represents the reaction that occur in the Cold-Pack

يُمثل التفاعل الذي يحدث في الكمادة الباردة

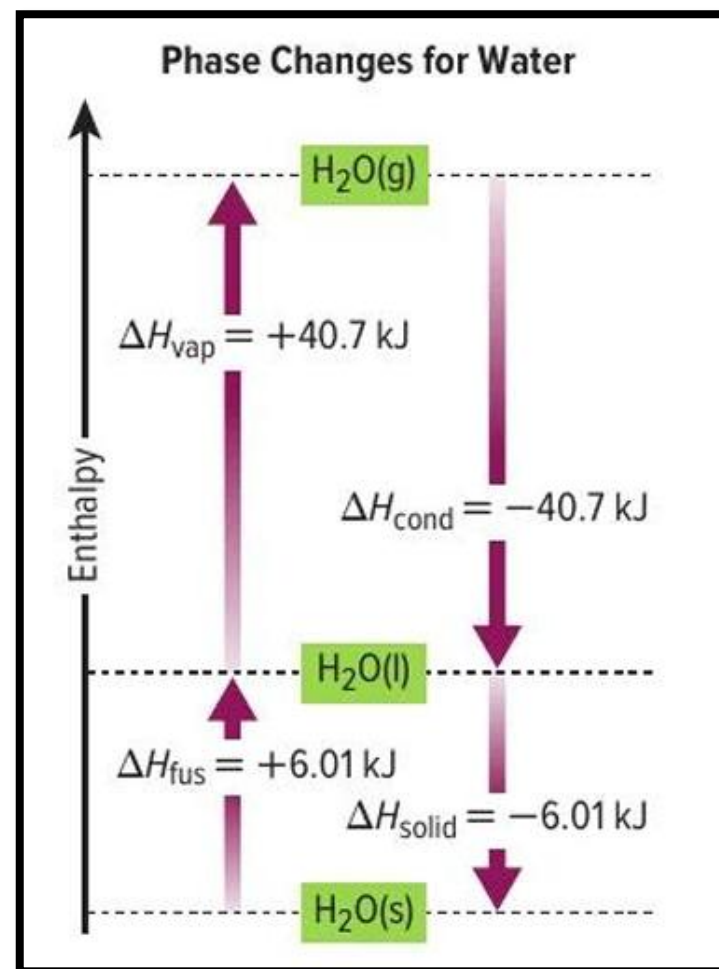
The enthalpy of the products is less than the enthalpy of the reactants

المحتوى الحراري للنواتج أقل من المحتوى الحراري للمواد المتفاعلة



$$\Delta H_{\text{vap}} = -\Delta H_{\text{cond}}$$

$$\Delta H_{\text{fus}} = -\Delta H_{\text{solid}}$$



Which of the following represents the cold pack process?

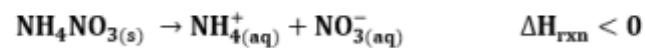
أي مما يلي يُمثل العملية التي تحدث في الكمادة الباردة؟



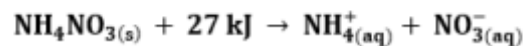
$\text{NH}_4\text{NO}_3(\text{s})$

Inner bag of water
كيس داخلي من الماء

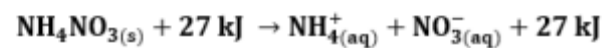
a.



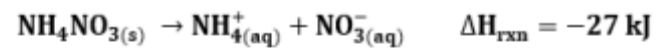
b.



c.

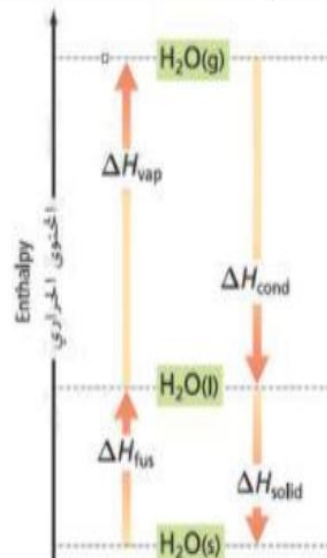


d.



Which of the following statements is **not correct** according to the diagram shown below?

أي العبارات التالية **غير صحيحة** اعتماداً على الشكل أدناه؟



A. The ΔH values of the molar enthalpy of vaporization and the molar enthalpy of fusion **are positive**

A. تكون قيم ΔH للحرارة المولية للتبخير والحرارة المولية للانصهار **موجبة**

B. The ΔH values of the molar enthalpy of condensation and molar enthalpy of solidification **are negative**

B. تكون قيم ΔH للحرارة المولية للتكثيف والحرارة المولية للتجمد **سالبة**

C. The molar enthalpy of solidification and the molar enthalpy of fusion have **the same numerical values but with opposite signs**

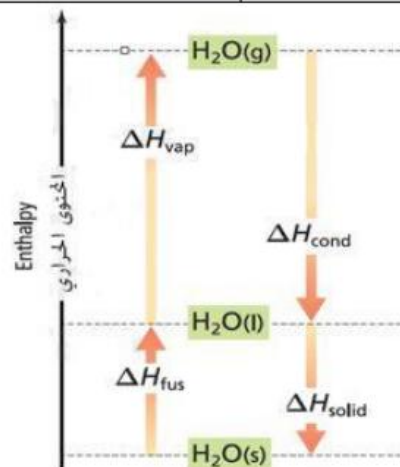
C. تتساوى القيمة العددية للحرارة المولية للتجمد مع القيمة العددية للحرارة المولية للانصهار ولكن **تختلف إشارتهما**

D. The molar enthalpy of condensation and the molar enthalpy of vaporization have **the same numerical values with same sign**

D. تتساوى القيمة العددية للحرارة المولية للتكثيف مع القيمة العددية للحرارة المولية للتبخير **وتتشابه إشارتهما**

Which of the following statement is **correct** according to the diagram shown below?

أي العبارات التالية **صحيحة** اعتمادًا على الشكل أدناه؟



A. The system energy decreases as ice melts and then evaporates

A. تقل طاقة النظام عند انصهار الثلج ثم تبخره

B. The system energy increases as water vapor condenses and then solidifies

B. تزيد طاقة النظام عند تكثف بخار الماء ثم تجمده

C. The vaporization of water and melting of ice are considered as exothermic process

C. تُعتبر عمليات تبخر الماء وصهر الثلج عمليات طاردة للحرارة

D. The condensation and solidification of water are considered as exothermic process

D. تُعتبر عمليات تكثف الماء وتجمده طاردة للحرارة

Using the figure below, how much heat in (kJ) is required to evaporate 156.1 g of water at 100°C?
(The molar mass of water is 18.02 g/mol)

لأنه، ما كمية الحرارة بوحدة (kJ) اللازمة لتبخير
من الماء عند درجة حرارة 100°C؟
ية للماء تساوي (18.02 g/mol)

Learning Outcomes Covered

- CHM.5.5.01.003

a.

353

b.

236

c.

185

d.

347

Water is sprayed on oranges during a frosty night. If an average of **29.5 g** of water freezes on each orange, how much heat is released?

يتم رش الماء على البرتقال خلال الليالي الباردة. إذا كان متوسط مقدار الماء الذي يتجمد على كل برتقالة هو **29.5 g** فما كمية الحرارة الناتجة؟

(الكتلة المولية للماء = 18.02 g/mol)

(molar mass of water = 18.02 g/mol)

a.

9.84 kJ

b.

66.6 kJ

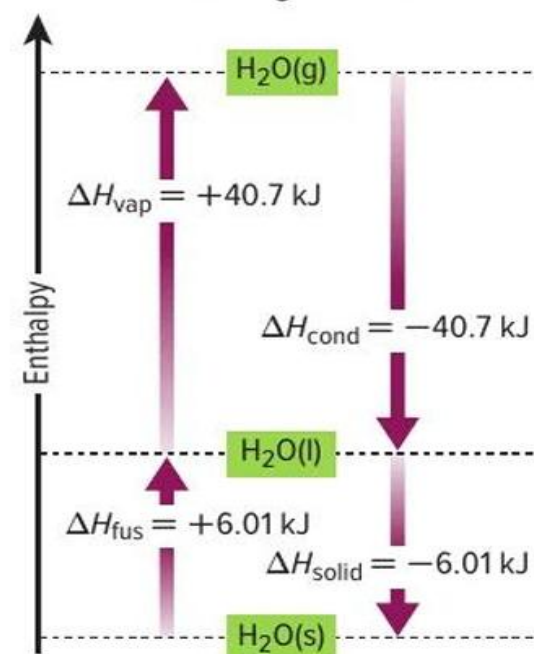
c.

3195 kJ

d.

21636 kJ

Phase Changes for Water



The **molar enthalpy of solidification** (ΔH_{solid}) is defined as the amount of **heat energy released** when **one mole** of a substance changes phase from a **liquid to a solid** at its constant freezing point and a constant pressure. 

The molar enthalpy of solidification is equal in magnitude but opposite in sign to the molar enthalpy of fusion (ΔH_{fus}), which is the heat absorbed when one mole of a solid melts to a liquid: 

$$\Delta H_{\text{solid}} = -\Delta H_{\text{fus}}$$



Some farmers make use of the heat of fusion of water to protect fruit and vegetables from freezing. If the temperature is predicted to drop to freezing, they flood their orchards or fields with water. When the water freezes, energy (ΔH_{fus}) is released and often warms the surrounding air enough to prevent frost damage.

What mass of propane (C_3H_8) in unit (g) is burned to release 9985.5 kJ of heat?

ما كتلة البروبان (C_3H_8) بوحدة (g) التي يتم حرقها لإنتاج 9985.5 kJ من الحرارة؟



The enthalpy (heat) of combustion of propane

حرارة احتراق البروبان ΔH_{comb}° هي -2219 kJ/mol

$$\Delta H_{comb}^\circ = -2219 \text{ kJ/mol}$$

والكتلة المولية للبروبان (44.097 g/mol)

Learning Outcomes Covered

- CHM.5.5.01.006

a.

198.0

b.

154.4

c.

110.3

d.

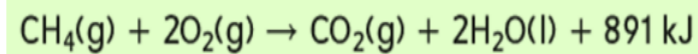
66.20

Using the equation below, how much heat ΔH_{comb} is released by burning 154 g of CH_4 methane?

معادلة أدناه، ما كمية الحرارة الناتجة ΔH_{comb} عن احتراق CH_4 الميثان؟

(Molar mass of methane is 16.04 g/mol)

(الكتلة المولية للميثان هي 16.04 g/mol)



Learning Outcomes Covered

- CHM.5.5.01.007

a.

 $4.50 \times 10^3 \text{ kJ}$

b.

 $5.20 \times 10^3 \text{ kJ}$

c.

 $6.70 \times 10^3 \text{ kJ}$

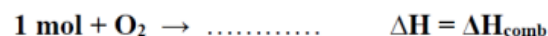
d.

 $8.60 \times 10^3 \text{ kJ}$

Enthalpy (heat) of Combustion: the change in enthalpy upon complete combustion of 1 mol of a substance.

What is ΔH_{comb} represents?

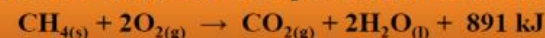
heat of combustion



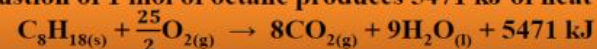
element or compound

any mole number

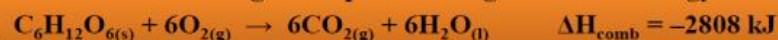
combustion of 1 mol of methane produces 891 kJ of heat energy



combustion of 1 mol of octane produces 5471 kJ of heat energy



combustion of glucose produces big amount of energy



hydrogen and oxygen react together to provide the energy needed to lift the space shuttle $\text{H}_{2(\text{g})} + \frac{1}{2}\text{O}_{2(\text{g})} \rightarrow \text{H}_2\text{O}_{(\text{l})} + 286 \text{ kJ}$

Which of the following equations represents a molar combustion equation?

- a. $2\text{NO}_{(\text{g})} + \text{O}_{2(\text{g})} \rightarrow 2\text{NO}_{2(\text{g})}$
- b. $2\text{SO}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightarrow 2\text{SO}_{3(\text{g})}$
- c. $\text{C}_6\text{H}_{12}\text{O}_{6(\text{s})} + 6\text{O}_{2(\text{g})} \rightarrow 6\text{CO}_{2(\text{g})} + 6\text{H}_2\text{O}_{(\text{g})}$
- d. $2\text{H}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightarrow 2\text{H}_2\text{O}_{(\text{g})}$

What is the complete thermochemical equation for the combustion of methane CH_4 if you know that $\Delta H_{\text{comb}} = -891 \text{ kJ/mol}$?

- a. $\text{CH}_{4(\text{g})} + 2\text{O}_{2(\text{g})} \rightarrow \text{CO}_{2(\text{g})} + 2\text{H}_2\text{O}_{(\text{l})} + 891 \text{ kJ}$
- b. $\text{CH}_{4(\text{g})} + 2\text{O}_{2(\text{g})} + 891 \text{ kJ} \rightarrow \text{CO}_{2(\text{g})} + 2\text{H}_2\text{O}_{(\text{l})}$
- c. $\text{CO}_{2(\text{g})} + 2\text{H}_2\text{O}_{(\text{l})} \rightarrow \text{CH}_{4(\text{g})} + 2\text{O}_{2(\text{g})} + 891 \text{ kJ}$
- d. $\text{CO}_{2(\text{g})} + 2\text{H}_2\text{O}_{(\text{l})} + 891 \text{ kJ} \rightarrow \text{CH}_{4(\text{g})} + 2\text{O}_{2(\text{g})}$

What mass of sucrose $C_{12}H_{22}O_{11}$ must be burned
in order to liberate **8466 kJ** of heat?

ما كتلة السكروز $C_{12}H_{22}O_{11}$ التي يجب حرقها لإنتاج **8466 kJ**
من الحرارة؟

Molar mass	الكتلة المولية	ΔH_{comb}°	Formula	الصيغة	Substance	المادة
342.3 g/mol		-5644 kJ/mol	$C_{12}H_{22}O_{11}$		Sucrose	السكروز

513.5 g

228.2 g

684.6 g

171.1 g

Using thermochemical equations, I, II and III below,

مُستخدماً المعادلات الكيميائية الحرارية I و II و III أدناه ،

What is the ΔH° value for the following reaction?

ما قيمة ΔH° للتفاعل التالي؟



I	$2\text{OF}_{2(g)} \rightarrow \text{O}_{2(g)} + 2\text{F}_{2(g)}$	$\Delta H^\circ = -49.9 \text{ kJ}$
II	$2\text{ClF}_{(g)} + \text{O}_{2(g)} \rightarrow \text{Cl}_2\text{O}_{(g)} + \text{OF}_{2(g)}$	$\Delta H^\circ = +205.6 \text{ kJ}$
III	$\text{ClF}_{3(g)} + \text{O}_{2(g)} \rightarrow \frac{1}{2}\text{Cl}_2\text{O}_{(g)} + \frac{3}{2}\text{OF}_{2(g)}$	$\Delta H^\circ = +266.7 \text{ kJ}$

Learning Outcomes Covered

- CHM.5.5.02.002

a.

+422 kJ

b.

+394 kJ

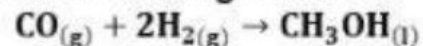
c.

-139 kJ

d.

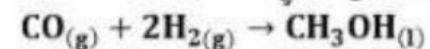
-188 kJ

How much is ΔH of the following reaction?



Use the thermochemical equations (a, b and c) shown below

ما قيمة ΔH للتفاعل التالي؟



استخدم المعادلات الكيميائية الحرارية a، b و c الموضحة أدناه

- a. $\text{CO}_{(g)} + \frac{1}{2}\text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} \quad \Delta H = -284 \text{ kJ}$
- b. $\text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \rightarrow \text{H}_2\text{O}_{(l)} \quad \Delta H = -286 \text{ kJ}$
- c. $\text{CH}_3\text{OH}_{(l)} + \frac{3}{2}\text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + 2\text{H}_2\text{O}_{(l)} \quad \Delta H = -727 \text{ kJ}$

-1297 kJ

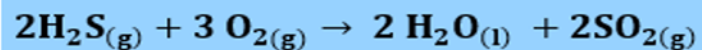
+1051 kJ

-129 kJ

+157 kJ

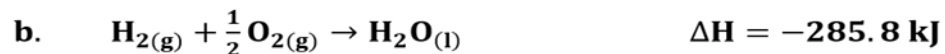
What is the value of ΔH for the following reaction?

ما قيمة ΔH للتفاعل التالي؟



Use thermochemical equations (a,b and c) shown below:

استخدم المعادلات الكيميائية الحرارية (a ، b و c) الموضحة أدناه:



-1124 kJ

-603.2 kJ

-1206 kJ

-562.0 kJ

Unfortunately, laboratory experiments to produce sulfur trioxide and determine its ΔH result in a mixture of products that is mostly sulfur dioxide (SO_2). In situations such as this, you can calculate ΔH by using Hess's law of heat summation. **Hess's law** states that if you can add two or more thermochemical equations to produce a final equation for a reaction, then the sum of the enthalpy changes for the individual reactions is the enthalpy change for the final reaction.

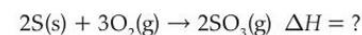
Chemists use a theoretical way to determine ΔH when:

- 1- The reaction is too slow.
- 2- The reaction occurs under conditions difficult to duplicate in a laboratory.
- 3- The reaction produces products other than the desired ones.

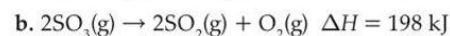
If you can add two or more thermochemical equations to produce a final equation for a reaction, then the sum of the enthalpy changes for the individual reactions is the enthalpy change for the final reaction.

1- Hess law

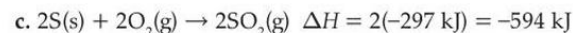
- 2- Le Chatelier's Principle
- 3- Gips law
- 4- Henry law



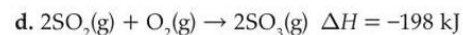
Step 1 Chemical equations are needed that contain the substances found in the desired equation and have known enthalpy changes. The following equations contain the substances S, O_2 , and SO_3 .



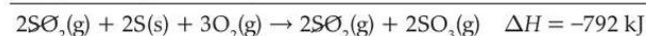
Step 2 The desired equation shows two moles of sulfur reacting, so rewrite Equation a for two moles of sulfur by multiplying the coefficients by two. Double the enthalpy change ΔH because twice the energy will be released if two moles of sulfur react. With these changes, Equation a becomes the following (Equation c).



Step 3 In the desired equation, sulfur trioxide is a product rather than a reactant, so reverse Equation b. When you reverse an equation, you must also change the sign of its ΔH . Equation b then becomes Equation d.



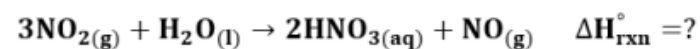
Step 4 Add Equations c and d to obtain the desired reaction. Add the corresponding ΔH values. Cancel any terms that are common to both sides of the combined equation.



المادة Substance	ΔH_f° (kJ/mol)
$\text{NO}_{2(g)}$	33.2
$\text{H}_2\text{O}_{(l)}$	-285.8
$\text{HNO}_{3(aq)}$	-207.4
$\text{NO}_{(g)}$	91.3

What is the $\Delta H_{\text{rxn}}^\circ$ value for the following reaction?

ما قيمة $\Delta H_{\text{rxn}}^\circ$ للتفاعل التالي؟



Learning Outcomes Covered

- CHM.5.4.02.006
- CHM.5.4.02.010
- CHM.5.4.02.021
- CHM.5.5.02.006

a.

-137 kJ

b.

-506 kJ

c.

+136 kJ

d.

+ 368 kJ

Standard heat of formation: the change in enthalpy that accompanies the formation of one mole of a compound from its elements that are in their standard state.

What is ΔH_f° represents?

standard heat of formation



any mole number

any mole number

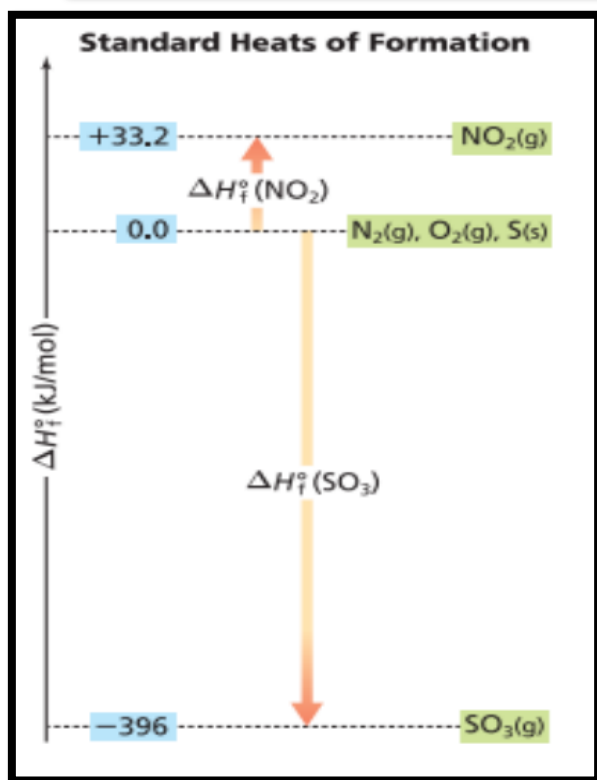


Table 5 Standard Enthalpies of Formation

Compound	Formation Equation	ΔH_f° (kJ/mol)
$\text{H}_2\text{S}(\text{g})$	$\text{H}_2(\text{g}) + \text{S}(\text{s}) \rightarrow \text{H}_2\text{S}(\text{g})$	-21
$\text{HF}(\text{g})$	$\frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{F}_2(\text{g}) \rightarrow \text{HF}(\text{g})$	-273
$\text{SO}_3(\text{g})$	$\text{S}(\text{s}) + \frac{3}{2}\text{O}_2(\text{g}) \rightarrow \text{SO}_3(\text{g})$	-396
$\text{SF}_6(\text{g})$	$\text{S}(\text{s}) + 3\text{F}_2(\text{g}) \rightarrow \text{SF}_6(\text{g})$	-1220

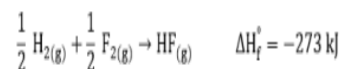
Which of the enthalpy changes in the following reactions **does not** represent a standard heat of formation ΔH_f° ?

أي من التغيرات في المحتوى الحراري في التفاعلات التالية لا يُمثل حرارة تكوين قياسية ΔH_f° ؟

Learning Outcomes Covered

◦ CHM.5.5.02.006

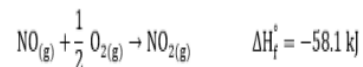
a.



b.



c.



d.



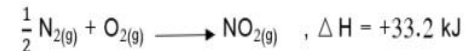
Which of the enthalpy changes in the following reactions represents a standard heat of formation (ΔH_f°) ?

تغيرات في المحتوى الحراري في التفاعلات التالية يُمثل حرارة نسبية (ΔH_f°) ؟

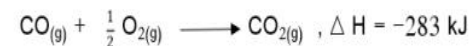
Learning Outcomes Covered

◦ CHM.5.5.02.006

a.



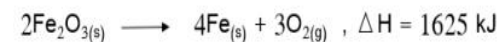
b.



c.



d.



Which of the ΔH values given in the following reactions

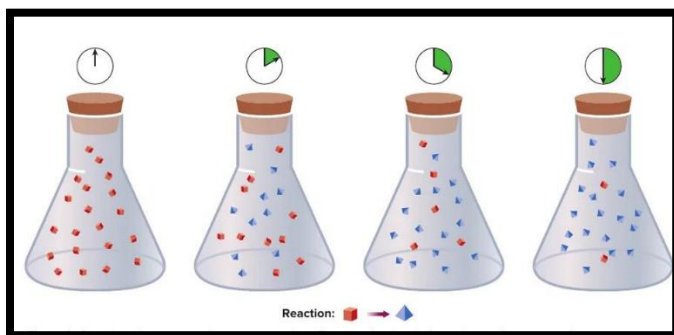
represents **the standard enthalpy of formation**

ΔH_f° of NO_2 compound?

أي من قيم ΔH المُعطاة في التفاعلات التالية تُمثل **حرارة التكوين القياسية**

ΔH_f° للمركب NO_2 ؟

1	$\text{NO}_{(g)} + \text{O}_{3(g)} \rightarrow \text{NO}_{2(g)} + \text{O}_{2(g)}$	$\Delta H = -199 \text{ kJ}$
2	$\frac{1}{2} \text{N}_{2(g)} + \text{O}_{2(g)} \rightarrow \text{NO}_{2(g)}$	$\Delta H = +33.2 \text{ kJ}$
3	$\text{N}_{2(g)} + 2\text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$	$\Delta H = +66.4 \text{ kJ}$
4	$\text{NO}_{(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{NO}_{2(g)}$	$\Delta H = -58.1 \text{ kJ}$

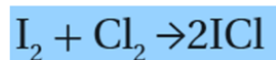


Average Reaction Rate Equation

$$\text{Average reaction rate} = -\frac{\Delta[\text{reactant}]}{\Delta t}$$

quantity		unit
symbol	meaning	
Rate	reaction rate	mol/(L.s)
k	specific rate constant	different units
[A]	reactant concentration	mol/L or M

In the gas-phase reaction :



$[\text{I}_2]$ changes from 0.400M at 0.00 min to 0.3840 M at 4.00 min.

What is the average reaction rate in moles of I_2 consumed per liter per minute?



يتغير $[\text{I}_2]$ من 0.400 M عند 0.00 min إلى 0.3840 M في 4.00 min

ما متوسط سرعة التفاعل بمولات I_2 المستهلكة بالتر لكل دقيقة؟

+0.004 mol/(L.min)

- 0.004 mol/(L.min)

+0.01 mol/(L.min)

- 0.01 mol/(L.min)

Using the experimental data in the following table,
if the average reaction rate for the reaction, expressed in
moles of NO formed, is 0.050 mol/L.s , what concentration of
NO would be present after 0.100 s?

مُستخدمًا البيانات التجريبية في الجدول التالي، إذا كان متوسط سرعة التفاعل مُعبرًا
عنه بعدد مولات NO الناتجة يساوي 0.05 mol/L.s ما تركيز NO بعد 0.100 s ؟

$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$			
[NO] (M)	[O ₂] (M)	[N ₂] (M)	الزمن (s) Time (s)
0.000	0.300	0.500	0.00
	0.250	0.450	0.100

a.

0.005

b.

0.5

c.

0.2

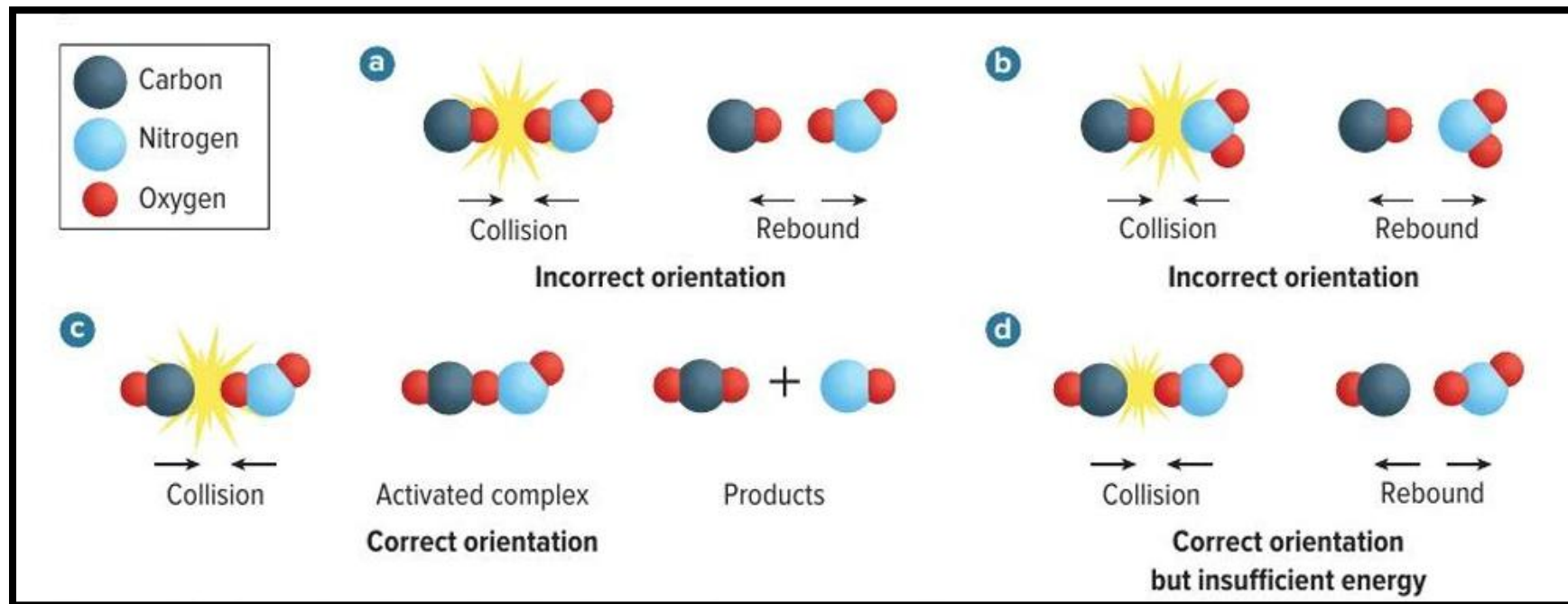


Table 1 Collision Theory Summary

1. Reacting substances (atoms, ions or molecules) must collide.
2. Reacting substances must collide in the correct orientation.
3. Reacting substances must collide with sufficient energy to form an activated complex.

The higher the activation energy, the slower the rate of reaction, and conversely, the lower the activation energy, the faster the rate of reaction.

Energy of Reaction

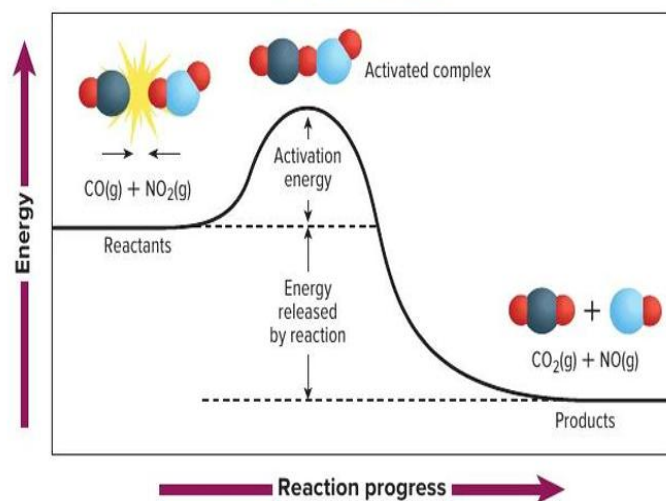


Figure 5 When an exothermic reaction occurs, molecules collide with enough energy to overcome the activation energy barrier. They form an activated complex, then release energy and form products at a lower energy level.

Energy of Reaction

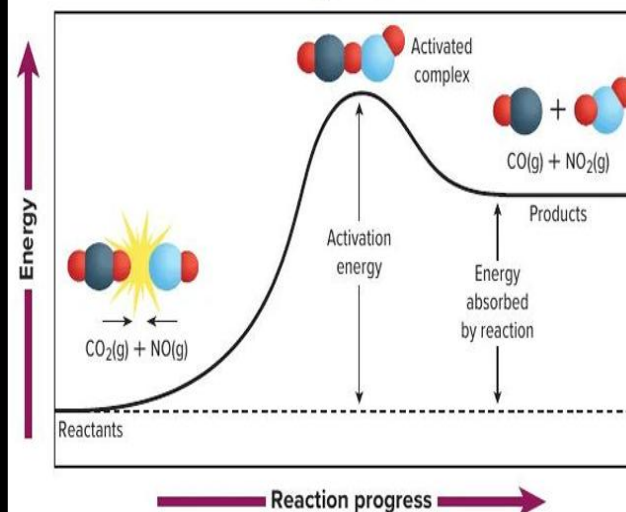


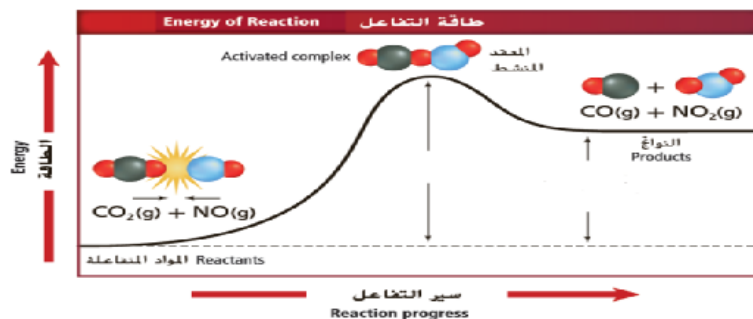
Figure 6 In a reverse reaction, which is endothermic, the reactant molecules are at a lower energy than the products. To react, the reactants must absorb enough energy to overcome the activation energy barrier and form higher-energy products.

What is the relationship between activation energy and chemical reaction rate ?

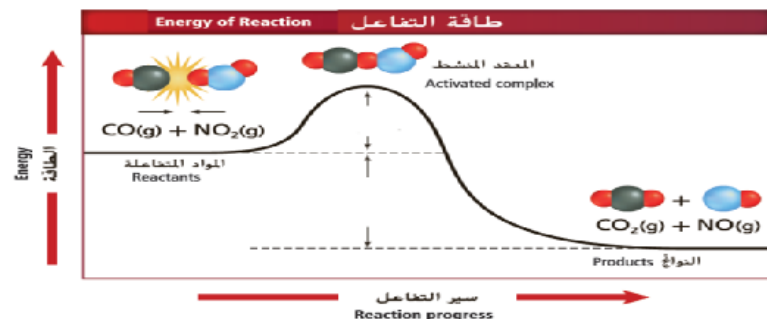
- 1- Direct proportional
- 2- Inverse
- 3- The same
- 4- No relation

Which of the following is **correct** regarding the two figures (1 and 2) below?

أي مما يلي **صحيح** فيما يتعلق بالشكلين (1 و2) أدناه؟



الشكل 2 Figure



الشكل 1 Figure

In figure 1 the reactant molecules collide with enough energy to overcome the activation energy barrier and form **higher** energy products

في الشكل 1 تتصادم جزيئات المتفاعلات بطاقة كافية للتغلب على حاجز طاقة التنشيط وتكون النواتج عند مستوى طاقة أكبر

The activation energy in figure 1 **larger** than activation energy in figure 2

طاقة التنشيط في الشكل 1 أكبر من طاقة التنشيط في الشكل 2

The reaction in figure 2 is exothermic, while the reaction in figure 1 it is endothermic

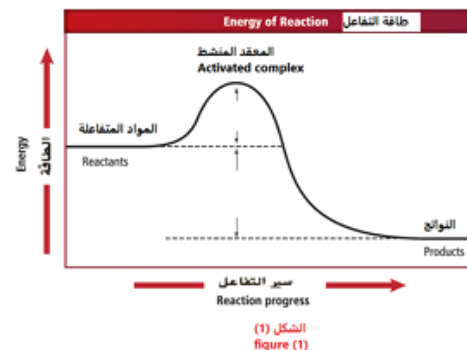
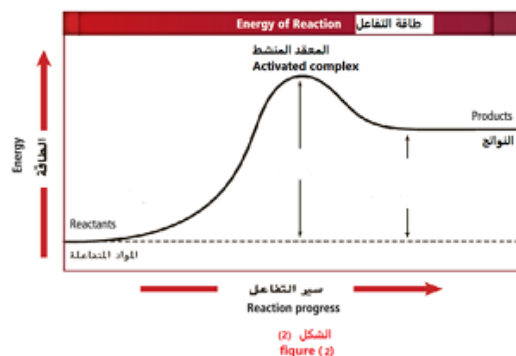
التفاعل في الشكل 2 طارد للحرارة، بينما التفاعل في الشكل 1 ماص للحرارة

In figure 2 the reactant molecules absorb enough energy to overcome the activation energy barrier and form **higher** energy products

في الشكل 2 تمتص جزيئات المتفاعلات طاقة كافية للتغلب على حاجز طاقة التنشيط وتشكل نواتج ذات طاقة أكبر

Using the two figures below, which of the following is **correct**?

مُستخدماً الشكلين أدناه، أي مما يلي **صحيح**؟



a.

Energy is released in figure (1) while energy is absorbed in figure (2)

تتطلق طاقة في الشكل (1) بينما تُمتص طاقة في الشكل (2)

b.

Energy is released in figure (2) while energy is absorbed in figure (1)

تتطلق طاقة في الشكل (2) بينما تُمتص طاقة في الشكل (1)

c.

The activation energy in figure (1) is greater than the activation energy in figure (2)

طاقة التنشيط في الشكل (1) أكبر من طاقة التنشيط في الشكل (2)



The general rate law for such reactions is described below.

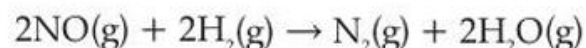
The General Rate Law

$$\text{rate} = k[A]^m[B]^n$$

[A] and [B] represent the concentrations of reactants A and B. The exponents m and n are the reaction orders.

The rate of a reaction is equal to the product of k and the concentrations of the reactants each raised to a power (order) that is determined experimentally.

Only if the reaction between A and B occurs in a single step (and with a single activated complex) does $m = a$ and $n = b$. That is unlikely, however, because single-step reactions are not common. For example, consider the multi-step reaction between nitrogen monoxide (NO) and hydrogen (H_2), which is described by the following equation.



This reaction has the following experimentally determined rate law.

$$\text{rate} = k[NO]^2[H_2]$$

If the next reaction occurs in a single step and with a single activated complex

The rate law for the reaction $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

So, $m = 2$ $n =$

When:
 $m = a, n = b$?

When the reaction between A and B occurs in one step and with only one activated complex.

Does the reaction: $aA + bB \rightarrow \text{products}$ always occur in one step?

No, because one-step reactions are not common.

One-step Reaction: $A \rightarrow B$

Reaction Rate: $\text{Rate} = k [A]$

The reaction: $aA + bB \rightarrow \text{products}$

Reaction Rate: $\text{Rate} = k[A]^m[B]^n$

What is the rate law for the reaction $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$ that is **first order**

in O_2 and third order in terms of reaction order?

a. $\text{Rate} = k [\text{NO}]^2[\text{O}_2]$

b. $\text{Rate} = k [\text{NO}]^3[\text{O}_2]$

c. $\text{Rate} = k [\text{NO}]^2[\text{O}_2]^3$

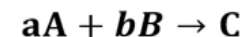
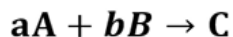
d. $\text{Rate} = k [\text{NO}][\text{O}_2]$

Use the experimental data in the following table.

استخدم البيانات التجريبية في الجدول التالي .

What is the rate law for the reaction?

ما قانون السرعة للتفاعل؟



البيانات التجريبية Experimental Data			
السرعة الابتدائية Initial Rate mol/(L.s)	التركيز الابتدائي Initial concentration [B] (M)	التركيز الابتدائي Initial concentration [A] (M)	التجربة Trial
8×10^{-8}	2.4	1.2	1
4×10^{-8}	1.2	1.2	2
7.2×10^{-7}	2.4	3.6	3

$$\text{Rate} = k[A]^2$$

$$\text{Rate} = k[A][B]$$

$$\text{Rate} = k[A]^2[B]$$

$$\text{Rate} = k[A][B]^2$$

Using the experimental data in the following table,
what is the rate law for the reaction?

مُستخدماً البيانات التجريبية في الجدول التالي، ما قانون السرعة للتفاعل؟

aA + bB → products			
السرعة الابتدائية Initial Rate (mol/(L.s))	التركيز الابتدائي Initial concentration [B] (M)	التركيز الابتدائي Initial concentration [A] (M)	التجربة Trial
3.00×10^{-3}	0.273	0.273	1
3.00×10^{-3}	0.273	0.546	2
6.00×10^{-3}	0.546	0.546	3

a.

$$\text{Rate} = k[A]$$

b.

$$\text{Rate} = k[A][B]$$

c.

$$\text{Rate} = k[A]^2[B]$$

d.

$$\text{Rate} = k[B]$$

The General Rate Law

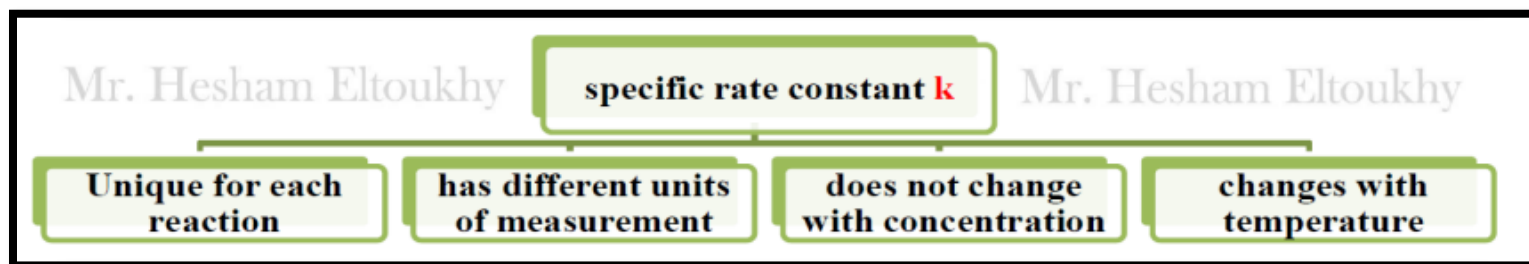
$$\text{rate} = k[A]^m[B]^n$$

$[A]$ and $[B]$ represent the concentrations of reactants A and B. The exponents m and n are the reaction orders.

The rate of a reaction is equal to the product of k and the concentrations of the reactants each raised to a power (order) that is determined experimentally.

The symbol k is the **specific rate constant**, a numerical value that relates the reaction rate and the concentrations of reactants at a given temperature. The specific rate constant is unique for every reaction and can have a variety of units including $\text{L}/(\text{mol}\cdot\text{s})$, $\text{L}^2/(\text{mol}^2\cdot\text{s})$, and s^{-1} . A rate law must be determined experimentally as illustrated in **Figure 15** on the previous page.

The rate law shows that the reaction rate is directly proportional to the molar concentration of A. The specific rate constant, k , does not change with concentration; however, k does change with temperature. A large value of k means that A reacts rapidly to form B.



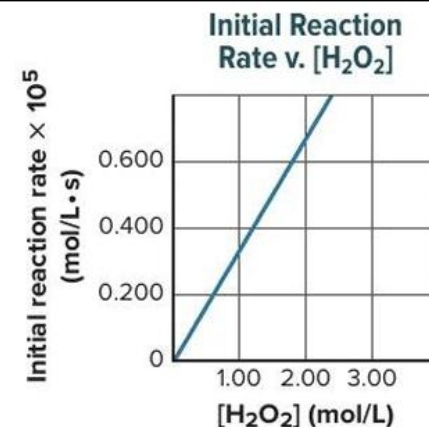
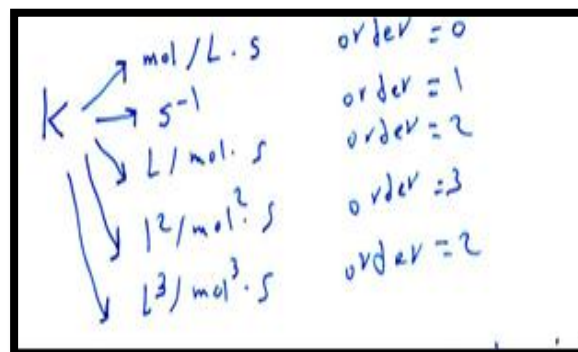
$$\text{Rate} = [\text{reactant}]^{\text{order}}$$

For a zero-order reactant, changing its concentration does not affect the rate of the reaction,

which means

the rate does not depend on the concentration of this reactant.

reaction order	1	2	3	4
k unit	s^{-1}	$\text{M}^{-1}\text{s}^{-1}$	$\text{M}^{-2}\text{s}^{-1}$	$\text{M}^{-3}\text{s}^{-1}$
rate unit	s^{-1}	$\text{L}/(\text{mol}\cdot\text{s})$	$\text{L}^2/(\text{mol}^2\cdot\text{s})$	$\text{L}^3/(\text{mol}^3\cdot\text{s})$
	$\text{mol}/(\text{L}\cdot\text{s})$			



The rate law for a certain reaction:

is $\text{Rate} = k[A][B]^2$

if the concentration of **B** is **halved**, and all other conditions remain unchanged, **how does the reaction rate change?**

قانون السرعة لتفاعل ما:

هو $\text{Rate} = k[A][B]^2$

إذا قل تركيز **B** إلى **النصف** وبقيت كل الظروف الأخرى ثابتة ، **كيف تتغير سرعة التفاعل ؟**

Decreases to a quarter of the initial reaction rate value

تقل إلى ربع قيمة السرعة الابتدائية

Quadruples (increases 4 times)

تتضاعف أربع مرات

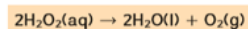
Decreases to half of the initial reaction rate value

تقل إلى نصف قيمة السرعة الابتدائية

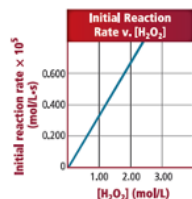
Doubles

تتضاعف

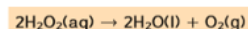
The following decomposition reaction:



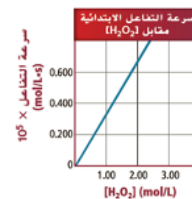
is first order, and the graph below shows relationship between its rate of decomposition and its concentration, when $[\text{H}_2\text{O}_2]$ equals 1.50 mol/L. Which of the following is the **correct unit** of the specific rate constant k ?



تفاعل التفكك التالي:



من الرتبة الأولى، ويوضح الرسم البياني أدناه العلاقة بين سرعة تفككه وتركيزه، عندما يكون $[\text{H}_2\text{O}_2]$ يساوي 1.50 mol/L. أي مما يلي هو **الوحدة الصحيحة** لثابت السرعة النوعية k ؟



a.

$\text{L}/(\text{mol}.\text{s})$

b.

$\text{L}^2/(\text{mol}^2.\text{s})$

c.

s^{-1}

What is the unit of the specific rate constant k for a reaction that has the rate law:

Rate = $[\text{A}]^2[\text{B}]$?

a. s^{-1}

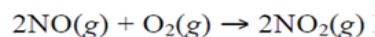
b. $\text{L}^2/(\text{mol}^2.\text{s})$

c. $\text{L}^3/(\text{mol}^3.\text{s})$

d. $\text{L}/(\text{mol}.\text{s})$

Mr. Hesham Eltoukhy

The chemical reaction :



التفاعل الكيميائي :

has the following rate law $\text{Rate} = k[\text{NO}]^2[\text{O}_2]$

if the concentration of NO decreases by half, what happens to the reaction rate?

له قانون السرعة التالي $\text{Rate} = k[\text{NO}]^2[\text{O}_2]$

إذا نقص تركيز NO إلى النصف، ماذا يحدث لـ سرعة التفاعل ؟

a.

Reduces to one-half

تنقص إلى النصف

b.

Becomes double

تُصبح الضعف

c.

Reduces to one-quarter

تنقص إلى الربع

d.

Remains the same

تبقى كما هو

Assume that a general chemical reaction has a rate law of **Rate = [A]²[B]³** and the rate of the reaction under known conditions is $4.5 \times 10^{-4} \text{ mol/(L.min)}$ if the concentrations of A and B are **doubled** and all other reaction conditions remain constant. How will the reaction rate change?

a. the reaction speed increases by a factor of 4 to become $1.8 \times 10^{-3} \text{ mol/(L.min)}$

b. the reaction speed increases by a factor of 8 to become $3.6 \times 10^{-3} \text{ mol/(L.min)}$

c. the reaction speed increases by a factor of 16 to become $7.2 \times 10^{-3} \text{ mol/(L.min)}$

d. the reaction speed increases by a factor of 32 to become $1.44 \times 10^{-2} \text{ mol/(L.min)}$

22	CHM.5.4.01.020.08 Calculate the instantaneous rate of a reaction from experimental data - calculate the concentration of a reactant using the instantaneous rate of a reaction	Textbook + Example problem 2 + Practice problems
23	CHM.5.4.01.020.08 Calculate the instantaneous rate of a reaction from experimental data	Textbook + Example problem 2 + Practice problems

The rate law for the reaction: $A + B + C \rightarrow \text{products}$
is :

$$\text{Rate} = k[B]^2[C]$$

If $k = 6.92 \times 10^{-5} \text{ L}^2/(\text{mol}^2 \cdot \text{s})$

and $[A] = 0.175 \text{ M}$, $[B] = 0.230 \text{ M}$, $[C] = 0.315 \text{ M}$.

What is the instantaneous reaction rate?

قانون السرعة للتفاعل : $A + B + C \rightarrow \text{نواتج}$
هو :

$$\text{Rate} = k[B]^2[C]$$

إذا كان $k = 6.92 \times 10^{-5} \text{ L}^2/(\text{mol}^2 \cdot \text{s})$

و $[C] = 0.315 \text{ M}$ ، $[B] = 0.230 \text{ M}$ ، $[A] = 0.175 \text{ M}$

ما هي سرعة التفاعل اللحظية؟

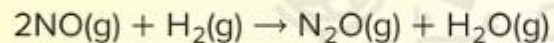
$$1.15 \times 10^{-6} \text{ mol}/(\text{L} \cdot \text{s})$$

$$8.77 \times 10^{-7} \text{ mol}/(\text{L} \cdot \text{s})$$

$$6.41 \times 10^{-7} \text{ mol}/(\text{L} \cdot \text{s})$$

$$5.01 \times 10^{-6} \text{ mol}/(\text{L} \cdot \text{s})$$

CALCULATE INSTANTANEOUS REACTION RATES The following reaction is first order in H_2 and second order in NO with a rate constant of $2.90 \times 10^2 \text{ (L}^2\text{/(mol}^2\cdot\text{s))}$.



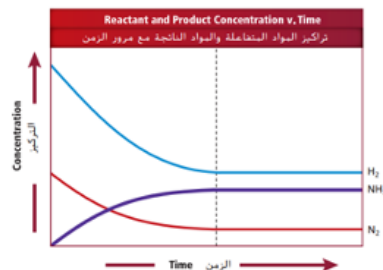
Calculate the instantaneous rate when the reactant concentrations are $[\text{NO}] = 0.00200\text{M}$ and $[\text{H}_2] = 0.00400\text{M}$.

Challenge Calculate $[\text{NO}]$ for the reaction in Example Problem 2 if the rate is $9.00 \times 10^{-5} \text{ mol/(L}\cdot\text{s)}$ and $[\text{H}_2]$ is 0.00300M .

The graph below shows the change in the concentrations of reactants, and products during the reaction of nitrogen and hydrogen to form ammonia.

Which of the following is **correct**?

يُظهر الرسم البياني أدناه تغير تراكيز المواد المتفاعلة والناجمة خلال تفاعل النيتروجين والهيدروجين لإنتاج الأمونيا. أي مما يأتي **صحيح**؟



Learning Outcomes Covered

- CHM.5.4.02.001

- a. The concentrations of the reactants increase at first
تتزايد تراكيز المواد المتفاعلة في البداية
- b. The concentrations of the reactants decrease at first
تتناقص تراكيز المواد المتفاعلة في البداية
- c. At equilibrium, the concentrations of products increase
عند الاتزان تتزايد تراكيز المواد الناتجة
- d. At equilibrium, the concentrations of products decrease
عند الاتزان تتناقص تراكيز المواد الناتجة

Q.4: كتابة تعابير الاتزان في الأنظمة المتزنة Equilibrium expression's writing for systems that are at equilibrium

Mark(s): 5/5

$\frac{[H_2][I_2]}{[HI]^2}$	$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$	A
$\frac{[Na_2CO_3][CO_2][H_2O]}{[NaHCO_3]^2}$	$2NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(g)$	B
$\frac{[CH_4][H_2O]}{[CO][H_2]^3}$	$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$	C
$\frac{[CaCO_3]}{[CaO]}$	$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$	D

a.

A

b.

B

c.

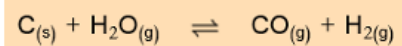
C

d.

D

What is the equilibrium constant expression
for the following reaction?

ما تعبير ثابت الاتزان للتفاعل التالي؟



Learning Outcomes Covered

- CHM.5.4.02.005

a.

$$\frac{[\text{CO}][\text{H}_2]}{[\text{C}][\text{H}_2\text{O}]}$$

b.

$$\frac{[\text{CO}][\text{H}_2]}{[\text{H}_2\text{O}]}$$

c.

$$\frac{[\text{C}][\text{H}_2\text{O}]}{[\text{CO}][\text{H}_2]}$$

d.

$$\frac{[\text{H}_2\text{O}]}{[\text{CO}][\text{H}_2]}$$

The reaction $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ reaches equilibrium. If the equilibrium concentrations are:

$[\text{SO}_2] = 0.0170 \text{ mol / L}$

$[\text{O}_2] = 0.0230 \text{ mol / L}$

K_{eq} is 4.32

$2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ يصل إلى حالة

كانت التراكيز عند الاتزان هي:

$[\text{O}_2] = 0.0230 \text{ mol / L}$ و $[\text{SO}_2] = 0.0170$

ن K_{eq} لهذا التفاعل هو 4.32

What is the equilibrium concentration of SO_3 in mol / L

الاتزان لـ SO_3 بوحدة mol / L ؟

Learning Outcomes Covered

- CHM.5.4.02.001

a.

0.00536

b.

0.0411

c.

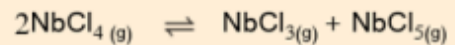
0.6850

d.

0.9970

The reaction below reaches equilibrium at a certain temperature

يصل التفاعل أدناه إلى حالة الاتزان عند درجة حرارة معينة،



, $K_{eq} = 6.90 \times 10^{-4}$, If the equilibrium concentrations are:

و $K_{eq} = 6.90 \times 10^{-4}$ ، إذا كانت تراكيز الاتزان هي:

$$\text{NbCl}_3 = 0.450 \text{ mol/L}, \quad \text{NbCl}_5 = 0.0380 \text{ mol/L}$$

What is the equilibrium concentration of NbCl_4 ?

فما تركيز الاتزان لـ NbCl_4 ؟

Learning Outcomes Covered

- CHM.5.4.02.006
- CHM.5.4.02.010
- CHM.5.4.02.021
- CHM.5.5.02.006

4.98 mol/L

2.75 mol/L

1.69 mol/L

5.65 mol/L

Exothermic Reaction

Equilibrium shifts to the left.



heat
Raise the temperature,

Equilibrium shifts to the right.



Lower the temperature,

Endothermic Reaction

Equilibrium shifts to the right.



heat
Raise the temperature,

Equilibrium shifts to the left.



Lower the temperature,

The chemical equilibrium system used to produce **ethane** C_2H_6 is:نظام الاتزان الكيميائي المستخدم في إنتاج الإيثان C_2H_6 هو:Which of the following **increases** the **ethane** C_2H_6 production?أي مما يلي **يزيد** من إنتاج الإيثان C_2H_6 ؟

إضافة C_2H_4 للنظام Adding C_2H_4 to the system	1
إزالة H_2 من النظام Removing H_2 from the system	2
زيادة درجة الحرارة Increasing temperature	3
تقليل الحجم Decreasing volume	4

1 ، 2 و 4

2 ، 3 و 4

1 ، 3 و 4

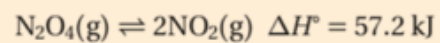
1 ، 2 و 3

The reaction in the equation below is endothermic.

التفاعل في المعادلة أدناه ماص للحرارة.

Which of the following is **correct**?

أي مما يأتي **صحيح**؟



عديم اللون بني محمر



1



2

Learning Outcomes Covered

- CHM.5.4.02.006
- CHM.5.4.02.010
- CHM.5.4.02.021
- CHM.5.5.02.006

a.

عند وضع وعاء التفاعل في حمام ساخن يظهر اللون 2

Placing reaction vessel in a boiling-water bath the color 2 appears

b.

عند وضع وعاء التفاعل في الثلج يظهر اللون 2

Placing reaction vessel in ice the color 2 appears

c.

عند وضع وعاء التفاعل في حمام ساخن ينزاح الاتزان جهة اليسار

Placing reaction vessel in a boiling-water bath the equilibrium shifts to the left

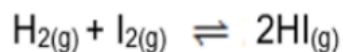
d.

عند وضع وعاء التفاعل في الثلج ينزاح الاتزان جهة اليمين

Placing reaction vessel in ice the equilibrium shifts to the right

What will be the result if the volume of the reaction vessel is decreased for the reaction?

ما نتيجة تقليل حجم وعاء التفاعل التالي؟



The concentration of the product increases

يزداد تركيز الناتج



The equilibrium shifts to the right

يتجه الاتزان نحو اليمين



The equilibrium does not change

لا يتغير الاتزان



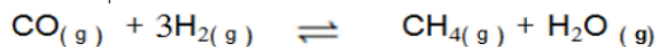
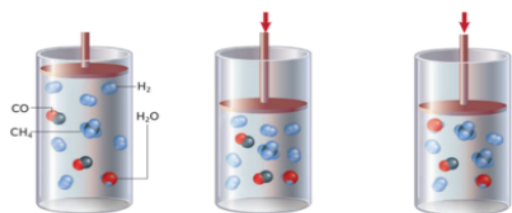
The equilibrium shifts to the left

يتجه الاتزان نحو اليسار



When **lowering** the piston in the figure below, what happens to the next equilibrium reaction?

عند ضغط المكبس إلى **أسفل** في الشكل أدناه ماذا يحدث لتفاعل الاتزان التالي؟



A - The equilibrium shifts to the left

A - ينزاح موضع الاتزان نحو اليسار

B - Increases the concentration of H_2

B - يزيد من تركيز H_2

C - The equilibrium shifts to the right

C - ينزاح موضع الاتزان نحو اليمين

D - Decreases the concentration of CH_4

D - يقل تركيز CH_4

Regarding the equilibrium systems given in the table below.

فيما يتعلق بأنظمة الاتزان الواردة في الجدول أدناه.

Which of the following is **correct**?

أي مما يأتي **صحيح**؟

$\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{HCl}(\text{g})$	1
$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$	2
$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$	3
$2\text{N}_2\text{H}_4(\text{g}) + 2\text{NO}_2(\text{g}) \rightleftharpoons 3\text{N}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$	4

Learning Outcomes Covered

- CHM.5.4.02.021

a.

Decreasing the volume of the reaction vessel
shifts the equilibrium **1** to the right

تقليل حجم وعاء التفاعل يُسبب إزالة الاتزان **1** إلى اليمين

b.

Decreasing the volume of the reaction vessel
shifts the equilibrium **2** to the left

تقليل حجم وعاء التفاعل يسبب إزالة الاتزان **2** إلى اليسار

c.

Increasing the volume of the reaction vessel
shifts the equilibrium **3** to the right

زيادة حجم وعاء التفاعل يسبب إزالة الاتزان **3** إلى اليمين

d.

Increasing the volume of the reaction vessel
shifts the equilibrium **4** to the left

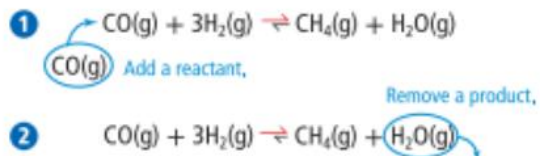
زيادة حجم وعاء التفاعل يسبب إزالة الاتزان **4** إلى اليسار

Figure 12 The addition or removal of a reactant or product shifts the equilibrium in the direction that relieves the stress. Note the unequal arrows, which indicate the direction of the shift.

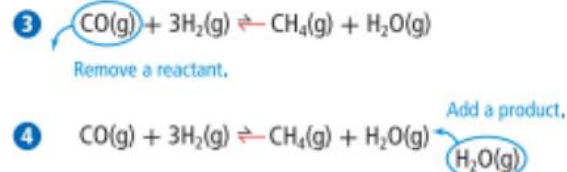
Describe how the reaction would shift if you added H_2 . If you removed CH_4 .



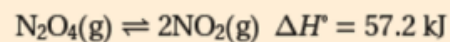
Equilibrium shifts to the right.



Equilibrium shifts to the left.



All the following changes cause the equilibrium to shift to the left in the reaction below except
 جميع التغيرات التالية تُسبب انزياح الاتزان إلى جهة اليسار في التفاعل أدناه عدا.....



Increasing the pressure

زيادة الضغط

Lowering the system temperature

خفض حرارة النظام

Reducing the concentration of NO_2

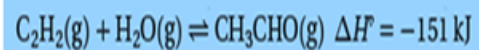
تقليل تركيز NO_2

Reducing the concentration of N_2O_4

تقليل تركيز N_2O_4

Which of the following increases CH_3CHO production in the following equilibrium reaction?

أي مما يلي يؤدي إلى زيادة إنتاج CH_3CHO في تفاعل الاتزان التالية؟



Decreasing temperature	خفض درجة الحرارة	1
Adding a lot of water	إضافة المزيد من الماء	2
Adding a catalyst	إضافة عامل حفاز	3
Adding a desiccant	إضافة عامل مجفف	4

a.

1 and 4

1 و 4

b.

1 and 2

1 و 2

c.

3 and 4

3 و 4

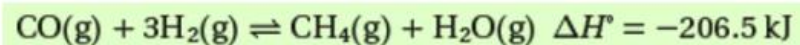
d.

4 and 5

4 و 5

All of the following changes cause the equilibrium to shift to the left in the reaction below except

جميع التغيرات التالية تُسبب انزياح الاتزان إلى جهة اليسار في التفاعل
أدناه عدا.....



Raising the system temperature

رفع درجة حرارة النظام

☐

Adding a desiccant to the reaction vessel

إضافة عامل مجفف في وعاء التفاعل

☐

Decreasing the concentration of CO

تقليل تركيز CO

☐

Decreasing the pressure

تقليل الضغط

☐

Catalysts and equilibrium

Changes in concentration, volume, and temperature make a difference in the amount of product formed in a reaction. Can a catalyst also affect product concentration? A catalyst speeds up a reaction, but it does so equally in both directions. Therefore, a catalyzed reaction reaches equilibrium more quickly but with no change in the amount of product formed. To maximize efficiency, industrial chemists try to produce the most amount of product in the shortest amount of time possible. As a result, many industrial processes involve both finely tuned equilibrium conditions and catalysts.

Which of the following factors will **NOT** lead to an increase in the amount of substance produced?

ب العوامل التالية لن تؤدي إلى زيادة كمية المادة الناتجة؟



Learning Outcomes Covered

- CHM.5.4.02.003
- CHM.5.4.02.006
- CHM.5.4.02.021

a.

Adding **CO** to the system

إضافة **CO** للنظام

b.

Removing **CH₃OH** from the system

إزالة **CH₃OH** من النظام

c.

Adding **H₂** to the system

إضافة **H₂** للنظام

d.

Adding a catalyst to the system

إضافة محفز للنظام