

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

☐

7.11×10^5 J

☐

1.7×10^5 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

Y



5.0×10^5 J

X

The energy in X is greater than in Y

الطاقة في X أكبر منها في Y

The energy in Y is 3.6×10^5 J

الطاقة في Y تساوي 3.6×10^5 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

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 = $4.184 \text{ J/g}\cdot^{\circ}\text{C}$

a.

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

b.

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

c.

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

d.

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

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

Equal masses of 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 (J / (g.°C)	1.023	0.129	0.301	0.647

Learning Outcomes Covered

- CHM.5.5.01.008

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

الأقل هو الكالسيوم ثم المغنيسيوم ثم الرصاص ثم السترونشيوم
- The lowest is calcium, then strontium, then magnesium, then lead

الأقل هو الكالسيوم ثم السترونشيوم ثم المغنيسيوم ثم الرصاص
- The lowest is magnesium, then calcium, then strontium, then lead

الأقل هو المغنيسيوم ثم الكالسيوم ثم السترونشيوم ثم الرصاص
- The lowest is lead, then strontium, then magnesium,

الأقل هو الرصاص ثم السترونشيوم ثم المغنيسيوم ثم الكالسيوم

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

ل 4655 . فما درجة الحرارة النهائية للإيثانول؟

النوعية للإيثانول هي (2.44 J/ (g. °C)

Learning Outcomes Covered

- CHM.5.5.01.008

a.

82.6°C

b.

67.4°C

c.

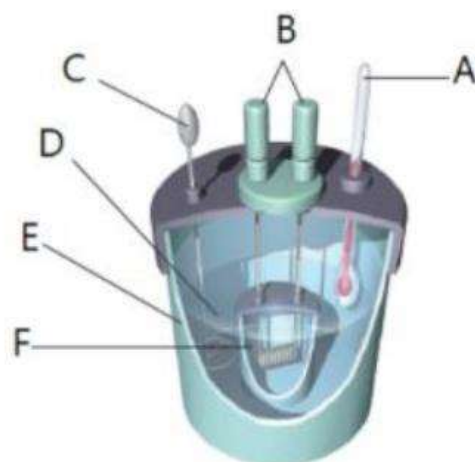
59.5°C

d.

45.8°C

In the figure below, which letter represents where the sample is placed?

في الشكل أدناه، ما الحرف الذي يُمثل المكان الذي توضع فيه العينة؟



Bomb Calorimeter

مُسعر احتراق

Which of the following statements is **incorrect** according to the foam-cup calorimeter?

أي العبارات التالية **غير صحيحة** حول المُسعر المصنوع من كوب بلاستيك رغوي؟

Learning Outcomes Covered

- CHM.5.5.01.002

a.

All reactions carried out in it occur at constant pressure

تحدث جميع التفاعلات بداخله تحت ضغط ثابت

b.

Used to determine the specific heat of unknown metal

يستخدم لتحديد الحرارة النوعية لفلز غير معلوم

c.

The data to be collected is the specific heat

تتمثل البيانات التي سيتم جمعها في الحرارة النوعية

d.

Worked in the open atmosphere

يعمل في الهواء الطلق

Why is there a low-friction stirrer in bomb calorimeter shown down?

لماذا يوجد محرك منخفض الاحتكاك في مُسرّع الاحتراق الموضح أدناه؟

a.

To ensure uniform temperature

b.

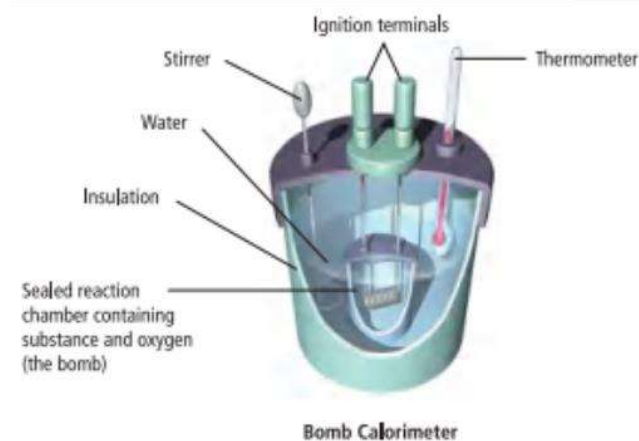
To ensure high friction creation

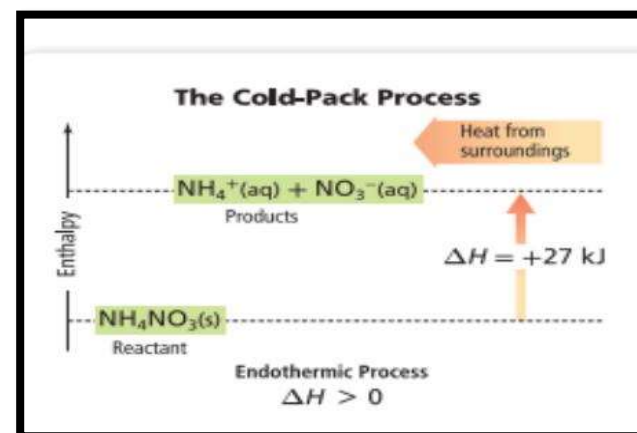
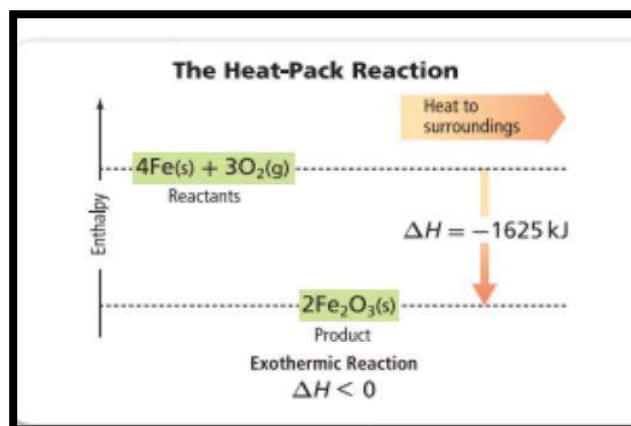
c.

To ensure the bomb is isolated from the surrounding

d.

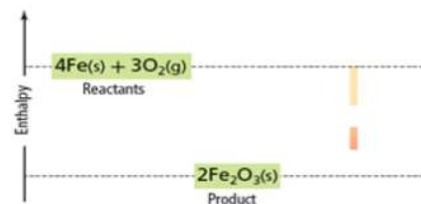
To ensure the initiation of the reaction





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

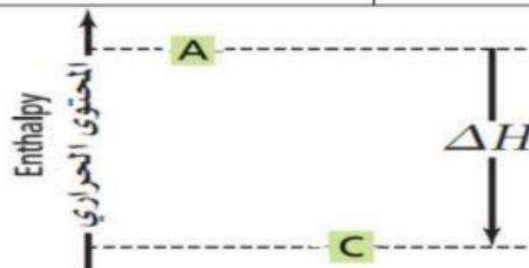
يُستخدم هذا التفاعل في الكمادة الساخنة

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: $A \rightarrow C$ الموضح بالشكل أدناه؟

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



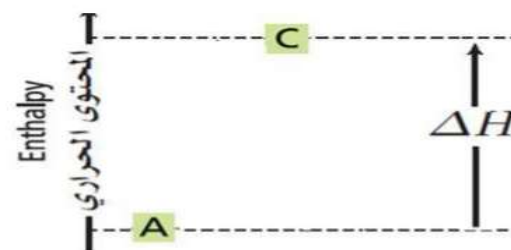
A. I only	A. فقط I
B. I and II only	B. I و II فقط
C. II and III only	C. II و III فقط
D. I and III only	D. I و III فقط

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II.	$H_{\text{الناتج}} < H_{\text{المتفاعلات}}$
III.	الحرارة تنتقل من المحيط إلى النظام



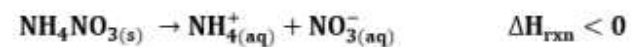
A. I only	A. فقط I
B. I and III only	B. I و III فقط
C. II and III only	C. II و III فقط
D. I and II only	D. I و II فقط

Which of the following represents the cold pack process?

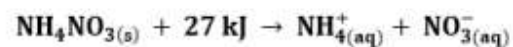
أي مما يلي يُمثل العملية التي تحدث في الكمادة الباردة؟



a.



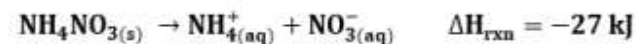
b.



c.



d.



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 barrium hydroxide and ammonium thiocyanate
crystals

لوح رطب
a wet board



Learning Outcomes Covered

o 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

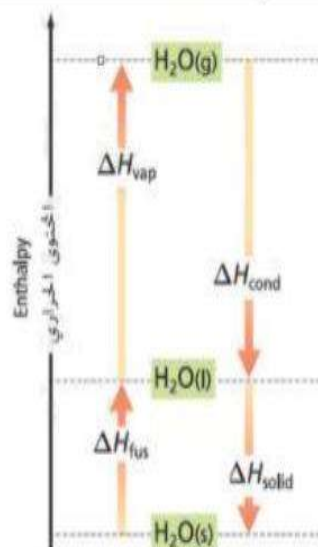
d.

From the system to the surroundings

من النظام إلى المحيط

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**

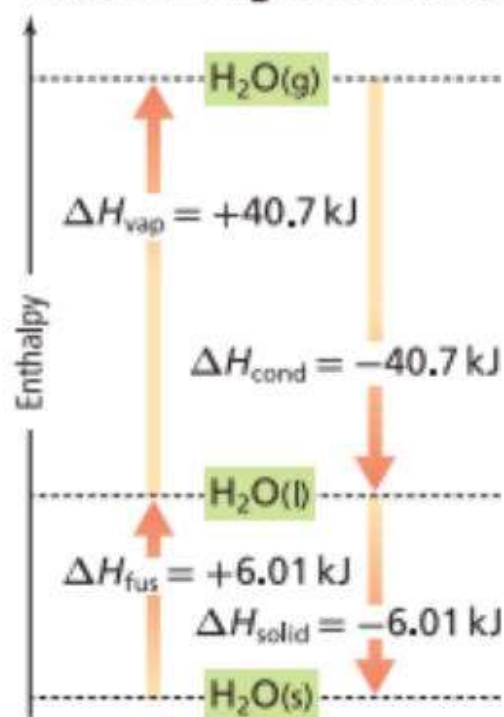
C. The molar enthalpy of solidification and the molar enthalpy of fusion have **the same numerical values but with opposite signs**

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**

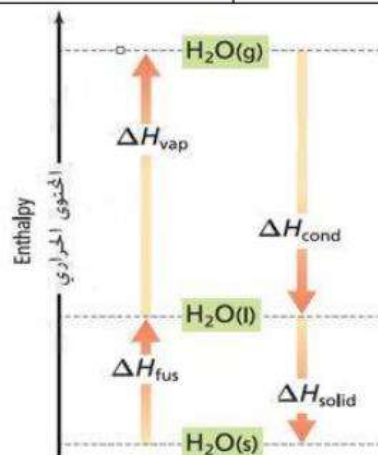
D. تتساوى القيمة العددية للحرارة المولية للتكثيف مع القيمة العددية للحرارة المولية للتبخير **وتتشابه إشارتهما**

Phase Changes for Water



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. نقل 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)

لأدناه، 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

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

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

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.

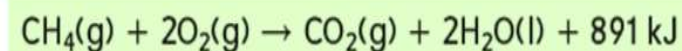
66.20

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**



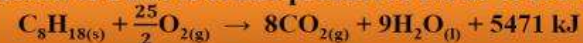
element or compound

any mole number

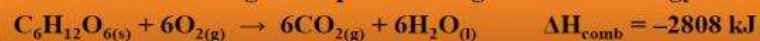
combustion of 1 mol of methane produces 891 kJ of heat energy



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

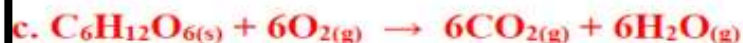


combustion of glucose produces big amount of energy



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?



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



Using thermochemical equations, I, II and III below,

مستخدمًا 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

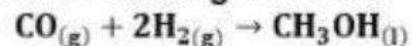
c.

-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

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

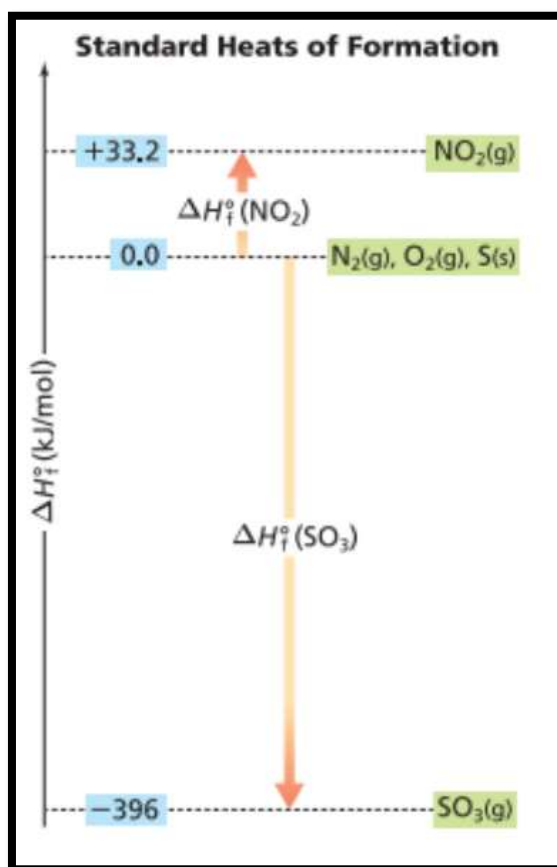


Table 5 Standard Enthalpies of Formation

Compound	Formation Equation	$\Delta H_f^\circ(\text{kJ/mol})$
$\text{H}_2\text{S}(\text{g})$	$\text{H}_2(\text{g}) + \text{S}(\text{s}) \rightarrow \text{H}_2\text{S}(\text{g})$	-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

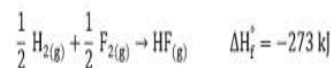
Which of the enthalpy changes in the following reactions **does not** represent a standard heat of formation ΔH_f° ?

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

Learning Outcomes Covered

◦ CHM.5.5.02.006

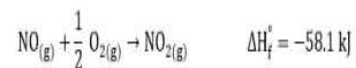
a.



b.



c.



d.



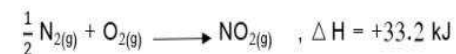
Which of the enthalpy changes in the following reactions represents a standard heat of formation (ΔH_f°) ?

تغيرات في المحتوى الحراري في التفاعلات التالية تمثل حرارة سية (ΔH_f°) ؟

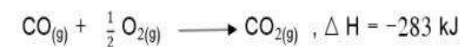
Learning Outcomes Covered

◦ CHM.5.5.02.006

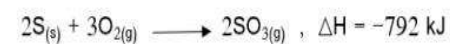
a.



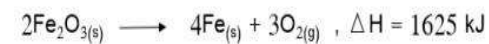
b.



c.



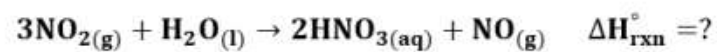
d.



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 ΔH_{rxn}° value for the following reaction?

ما قيمة ΔH_{rxn}° 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

Which of the data in the following table is correct?

في الجدول التالي صحيحة؟

إشارة التغير في المحتوى الحراري The sign of the enthalpy change	التغير في المحتوى الحراري The change in enthalpy	العملية Process	الرقم Number
positive	موجبة	exothermic	طاردة للحرارة
positive	موجبة	endothermic	ماصة للحرارة
negative	سالبة	endothermic	ماصة للحرارة
negative	سالبة	exothermic	طاردة للحرارة

Learning Outcomes Covered

- CHM.5.5.01.003

a. 1 only

b. 4 only

c. 1, 2

d. 3, 4

In which of the following cases does the random motion (entropy) of the particles of the substance increases?

الحركة العشوائية (الانتروبي) لجسيمات

$2\text{CO}_{(g)} + \text{O}_{2(g)} \longrightarrow 2\text{CO}_{2(g)}$	1
$\text{HCl}_{(g)} \longrightarrow \text{HCl}_{(aq)}$	2
$\text{NaCl}_{(s)} \longrightarrow \text{Na}^+_{(aq)} + \text{Cl}^-_{(aq)}$	3
$2\text{SO}_{3(g)} \longrightarrow 2\text{SO}_{2(g)} + \text{O}_{2(g)}$	4

Learning Outcomes Covered

- CHM.5.5.02.008

a. 1 only

b. 3 only

c. 1, 2 together

d. 3, 4 together

$$\Delta H = -27.6 \text{ kJ}, \Delta S = -55.2 \text{ J/K}, T = 535 \text{ K}$$

Which of the data in the following table is **correct**?

أي من البيانات الواردة في الجدول التالي **صحيحة**؟

	ΔG العملية Process	تلقائية العملية Process spontaneity
A	+1.93 kJ	nonspontaneous غير تلقائية
B	-1.93 kJ	spontaneous تلقائية
C	+75.1 kJ	nonspontaneous غير تلقائية

Learning Outcomes Covered

- CHM.5.5.02.009

a.

A

b.

B

c.

C

d.

D

Calculating free energy change حساب تغير الطاقة الحرة

What is the ΔG_{system} value of the following process?

$\Delta S_{\text{system}} = 195 \text{ J/K}$, $\Delta H_{\text{system}} = 145 \text{ kJ}$ and $T = 293 \text{ K}$?

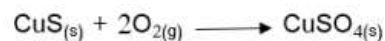
ما قيمة $\Delta G_{\text{النظام}}$ للعملية التالية

$\Delta S_{\text{النظام}} = 195 \text{ J/K}$ و $\Delta H_{\text{النظام}} = 145 \text{ kJ}$ و $T = 293 \text{ K}$ ؟

- a. ☐ + 87.9 kJ
- b. ☐ $- 5.7 \times 10^4 \text{ kJ}$
- c. ☐ $- 4.25 \times 10^4 \text{ kJ}$
- d. ☐ +152.5 kJ

Copper (II) sulfide reacts with oxygen under standard conditions to form copper (II)sulfate as shown in the equation below. Which of the following is correct?

يتفاعل كبريتيد النحاس (II) مع الأكسجين في ظل ظروف قياسية لتكوين كبريتات النحاس (II) كما في المعادلة أدناه. أي مما يأتي صحيح؟



$$\Delta H_{\text{rxn}}^{\circ} = -718.3 \text{ kJ} , \Delta S_{\text{rxn}}^{\circ} = -368.0 \text{ J/K}$$

العملية (تلقائية / غير تلقائية) Process (Spontaneous / Non-Spontaneous)	$\Delta G^{\circ} \text{ (kJ)}$	
Nonspontaneous غير تلقائية	+727.5	A
Spontaneous تلقائية	-609.0	B
Nonspontaneous غير تلقائية	+571.8	C
Spontaneous تلقائية	-571.8	D

■ **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.

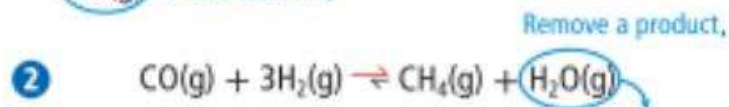
Describe how the reaction would shift if you added H_2 . If you removed CH_4 .



Equilibrium shifts to the right.



$CO(g)$ Add a reactant,

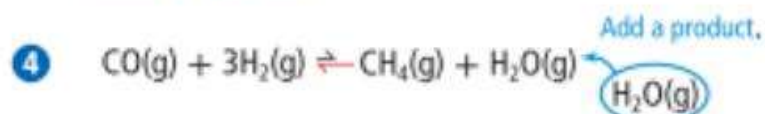


Remove a product,

Equilibrium shifts to the left.



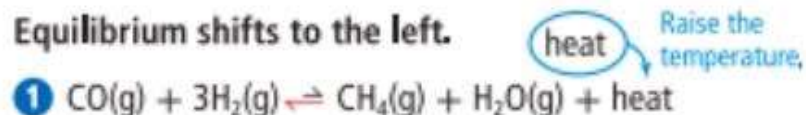
Remove a reactant,



Add a product,

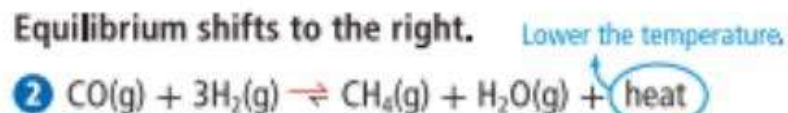
Exothermic Reaction

Equilibrium shifts to the left.



heat Raise the temperature,

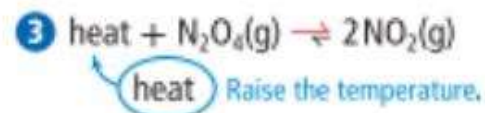
Equilibrium shifts to the right.



Lower the temperature,

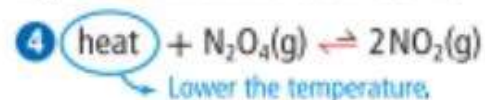
Endothermic Reaction

Equilibrium shifts to the right.



heat Raise the temperature,

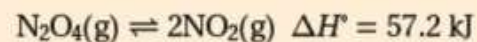
Equilibrium shifts to the left.



Lower the temperature,

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

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



زيادة الضغط

Increasing the pressure

خفض حرارة النظام

Lowering the system temperature

تقليل تركيز NO_2

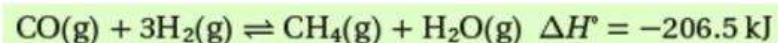
Reducing the concentration of NO_2

تقليل تركيز N_2O_4

Reducing the concentration of N_2O_4

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

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



رفع درجة حرارة النظام ☐

Raising the system temperature

إضافة عامل مجفف في وعاء التفاعل ☐

Adding a desiccant to the reaction vessel

تقليل تركيز CO ☐

Decreasing the concentration of CO

تقليل الضغط ☐

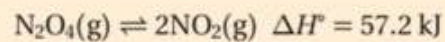
Decreasing the pressure

The reaction in the equation below is endothermic.

Which of the following is **correct**?

التفاعل في المعادلة أدناه ماص للحرارة.

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

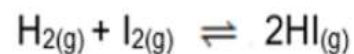
d.

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



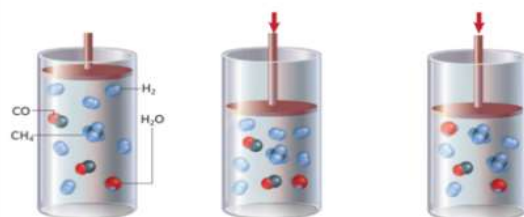
The equilibrium shifts to the left

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

فيما يتعلق بأنظمة الاتزان الواردة في الجدول أدناه.

Regarding the equilibrium systems given in the table below.

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

o 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 إزاحة الاتزان **1** إلى اليمين

b.

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

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

c.

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

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

d.

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

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

The reaction below reaches equilibrium at a certain temperature

يصل التفاعل أدناه إلى حالة الاتزان عند درجة حرارة معينة،



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

و $K_{\text{eq}} = 6.90 \times 10^{-4}$ ، 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

If the K_{sp} of calcium hydroxide Ca(OH)_2 is 5.32×10^{-6} at 298 K. What is the solubility of calcium hydroxide in mol/L?

قيمة K_{sp} لهيدروكسيد الكالسيوم Ca(OH)_2 تساوي 5.32×10^{-6} عند 298 K . فما ذائبية هيدروكسيد الكالسيوم بوحدة mol/L?

**Learning Outcomes Covered**

- CHM.5.4.02.008

a.

$$1.10 \times 10^{-2}$$

b.

$$1.60 \times 10^{-3}$$

c.

$$2.80 \times 10^{-7}$$

d.

$$3.30 \times 10^{-8}$$

When 62.6 mL of aqueous solution 0.0322M CaCl_2 and 31.3 mL of aqueous solution 0.0145M NaOH are mixed.

Which of the following is **correct**?

$$K_{sp} = 5.0 \times 10^{-6} \text{ for } \text{Ca(OH)}_2 \text{ compound}$$

عند خلط 62.6 mL من المحلول المائي 0.0322 M CaCl_2 و 31.3 mL من المحلول المائي 0.0145 M NaOH أي مما يأتي **صحيح**؟

$$K_{sp} \text{ للمركب } \text{Ca(OH)}_2 = 5.0 \times 10^{-6}$$

Learning Outcomes Covered

- CHM.5.4.02.010

a.

$Q_{sp} = 5.01 \times 10^{-7}$ and no precipitate is formed

$Q_{sp} = 5.01 \times 10^{-7}$ ولا يتكون راسب

b.

$Q_{sp} = 1.03 \times 10^{-4}$ and a precipitate is formed

$Q_{sp} = 1.03 \times 10^{-4}$ ويتكون راسب

c.

$Q_{sp} = 4.55 \times 10^{-5}$ and a precipitate is formed

$Q_{sp} = 4.55 \times 10^{-5}$ ويتكون راسب

d.

$Q_{sp} = 7.50 \times 10^{-8}$ and no precipitate is formed

$Q_{sp} = 7.50 \times 10^{-8}$ ولا يتكون راسب

If an equal volumes of the solutions 0.0322 M CaCl_2 and 0.0145 M NaOH are mixed, a precipitate of Ca(OH)_2 is predicted. Which of the following is true?

لـ حجـوم متساوية من محلول CaCl_2 تركيزه 0.0322 M ومحلول NaOH تركيزه 0.0145 M يُتوقع أن بـ من Ca(OH)_2 . أي مما يأتي صحيح؟

Solubility Product Constants at 298 K for the compound Ca(OH)_2 ($K_{sp} = 5.0 \times 10^{-6}$)

لـ الإذابة عند 298 K للمركب Ca(OH)_2 هو ($K_{sp} = 5.0 \times 10^{-6}$)

Learning Outcomes Covered

- CHM.5.4.02.008
- CHM.5.4.02.009

a.

$Q_{sp} = 8.5 \times 10^{-7}$ and a precipitate will not form

$Q_{sp} = 8.5 \times 10^{-7}$ ولا يتكون راسب

b.

$Q_{sp} = 2.6 \times 10^{-5}$ and a precipitate will form

$Q_{sp} = 2.6 \times 10^{-5}$ ويتكون راسب

c.

$Q_{sp} = 4.9 \times 10^{-10}$ and a precipitate will form

$Q_{sp} = 4.9 \times 10^{-10}$ ويتكون راسب

d.

$Q_{sp} = 2.5 \times 10^{-4}$ and a precipitate will not form

$Q_{sp} = 2.5 \times 10^{-4}$ ولا يتكون راسب

Using the data in the corresponding table. What is the average reaction rate expressed in moles of H_2 consumed per liter per second?

a. $1.25 \times 10^{-3} \text{ mol/(L.s)}$

b. $5 \times 10^{-3} \text{ mol/(L.s)}$

c. $2.5 \times 10^{-3} \text{ mol/(L.s)}$

d. $7.5 \times 10^{-3} \text{ mol/(L.s)}$

Experimental Data for $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$			
Time (s)	$[\text{H}_2]$ (M)	$[\text{Cl}_2]$ (M)	$[\text{HCl}]$ (M)
0.00	0.030	0.050	0.000
4.00	0.020	0.040	

Using the data in the corresponding table. What is the average reaction rate expressed in moles of Cl_2 consumed per liter per second?

a. $2.5 \times 10^{-3} \text{ mol/(L.s)}$

b. $1.25 \times 10^{-3} \text{ mol/(L.s)}$

c. $7.5 \times 10^{-3} \text{ mol/(L.s)}$

d. $5 \times 10^{-3} \text{ mol/(L.s)}$

Experimental Data for $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$			
Time (s)	$[\text{H}_2]$ (M)	$[\text{Cl}_2]$ (M)	$[\text{HCl}]$ (M)
0.00	0.030	0.050	0.000
4.00	0.020	0.040	

Using the data in the corresponding table. If the average reaction rate expressed as moles of HCl produced is 0.005 mol/(L.s) , what is the concentration of HCl after 4 s?

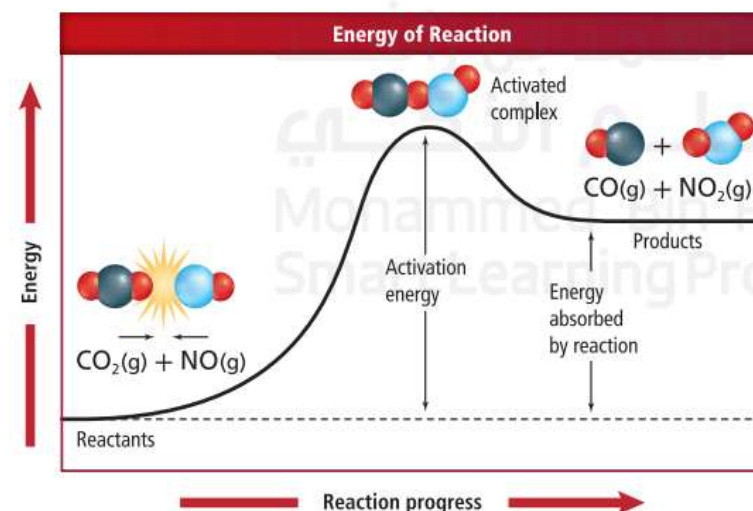
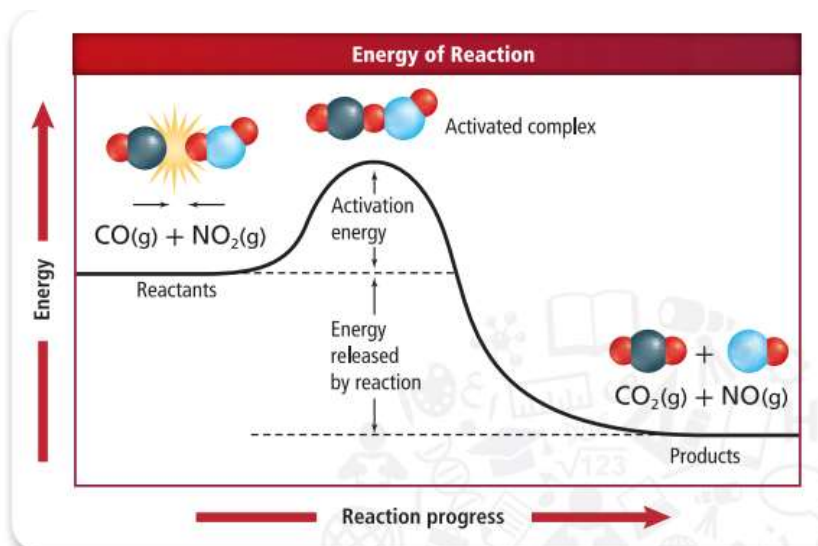
a. $1.25 \times 10^{-3} \text{ M}$

b. 1.25 M

c. 8 M

d. 0.02 M

Experimental Data for $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$			
Time (s)	$[\text{H}_2]$ (M)	$[\text{Cl}_2]$ (M)	$[\text{HCl}]$ (M)
0.00	0.030	0.050	0.000
4.00	0.020	0.040	



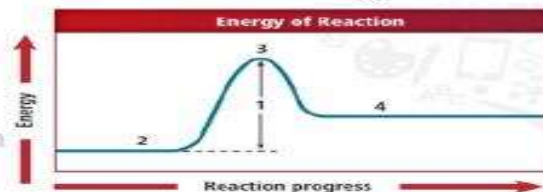
8) What is the relationship between activation energy and reaction rate?

- a. The lower the activation energy, the lower the reaction rate
- b. The higher the activation energy, the faster the reaction rate
- c. The higher the activation energy, the slower the reaction rate
- d. There is no relationship between them

9) Which of the following **does not** describe the rate of a chemical reaction?

- a. The speed at which the reaction occurs
- b. The amount of products produced in a certain period of time
- c. The change in the concentration of one of the reactants per unit time
- d. Change in concentration of a product per unit time

11) Based on the corresponding figure, which of the following choices represents the correct symbols on the drawing?



choice	1	2	3	4
a.	activation energy	products	activated complex	reactants
b.	activation energy	reactants	activated complex	products
c.	activated complex	products	activation energy	reactants
d.	activated complex	reactants	activation energy	products

12) What happens during the short-term presence of the activated complex?

- a. bonds are formed between reactants, and bonds are broken between products
- b. bonds are formed between reactants, and bonds are formed between products
- c. bonds are broken between reactants, and bonds are broken between products
- d. bonds are broken between reactants, and bonds are formed between products

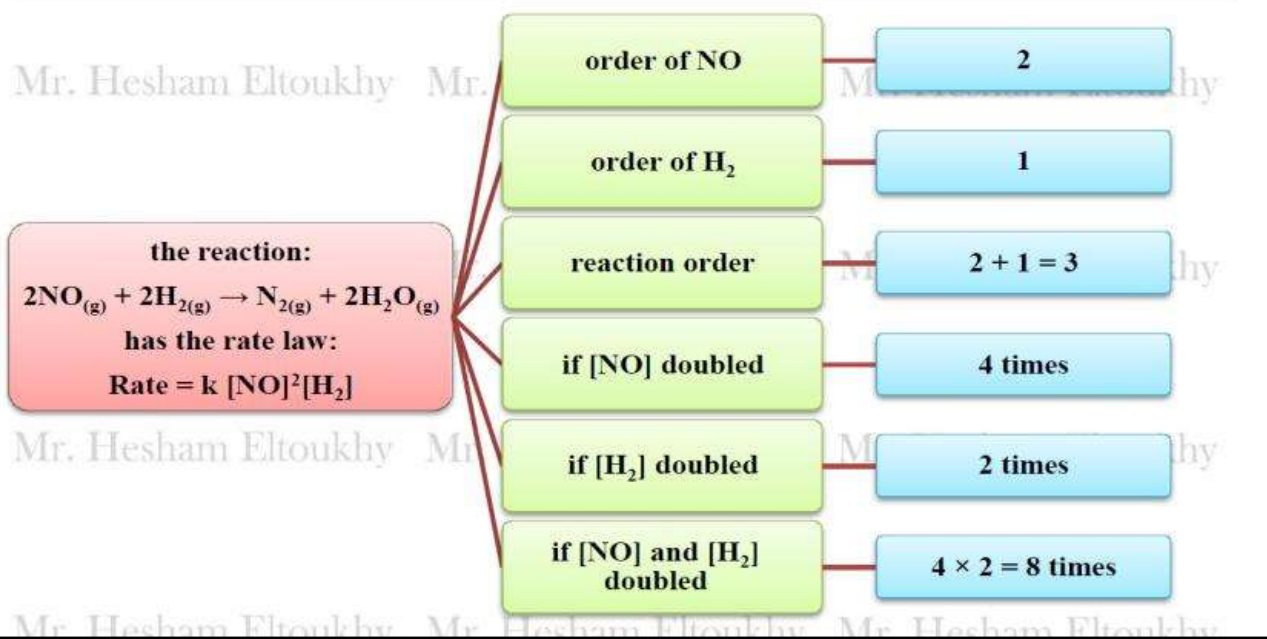
13) If the reaction $A \rightarrow B$ is exothermic. What is the relationship between the activation energy of the forward reaction? And the activation energy for the endothermic reversible reaction $A \leftarrow B$?

- a. activation energy for the exothermic forward reaction > activation energy for the endothermic reverse reaction
- b. activation energy for the exothermic forward reaction < activation energy for the endothermic reverse reaction
- c. activation energy for the exothermic forward reaction = activation energy for the endothermic reverse reaction
- d. there is no relationship between them

Determining reaction order

Method of initial rates: a method that determines reaction order by comparing the initial rates of a reaction carried out with varying reactant concentrations.

Initial rate: measure how fast the reaction proceeds at the moment at which the reactants are mixed, and the concentrations of reactants are known.



One-step Reaction: $\text{A} \rightarrow \text{B}$

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

The reaction: $a\text{A} + b\text{B} \rightarrow \text{products}$

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

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.

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

What is the reaction order of the reaction between A and B, if you know its rate law?

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

a. 1

b. 2

c. 3

d. 4

The reaction: $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$ has a rate law: **Rate = k [NO]²[O₂]**.

Does the reaction occur in one step?

- a. no, because the coefficients in the equation = orders in the rate law
- b. no, because the coefficients in the equation $\neq$ the orders in the rate law
- c. yes, because the coefficients in the equation = the orders in the rate law
- d. yes, because the coefficients in the equation $\neq$ the orders in the rate law

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 4.5×10^{-4} 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 1.8×10^{-3} mol/(L.min)
- b. the reaction speed increases by a factor of 8 to become 3.6×10^{-3} mol/(L.min)
- c. the reaction speed increases by a factor of 16 to become 7.2×10^{-3} mol/(L.min)
- d. the reaction speed increases by a factor of 32 to become 1.44×10^{-2} mol/(L.min)

27) If the rate law for the reaction with data in the table below is:

Rate = k [CH₃N₂CH₃], What is the value of the specific velocity constant k?

a. $2.08 \times 10^{-4} \text{ s}^{-1}$

b. $4.16 \times 10^{-4} \text{ s}^{-1}$

c. $4.34 \times 10^{-8} \text{ s}^{-1}$

d. $8.68 \times 10^{-8} \text{ s}^{-1}$

Initial [CH ₃ N ₂ CH ₃] (mol/L)	Initial rate mol/(L.s)
0.012	2.5×10^{-6}
0.024	5.0×10^{-6}

Use the results in the table below to determine the reaction rate law.



Trial	Initial [NO] (mol/L)	Initial [H ₂] (mol/L)	Initial rate mol/(L.s)
1	5.0×10^{-3}	2.5×10^{-3}	3.0×10^{-5}
2	1.5×10^{-4}	2.5×10^{-3}	9.0×10^{-5}
3	1.5×10^{-4}	1.0×10^{-4}	3.6×10^{-4}

a. **Rate = k [NO]²[H₂]²**

b. **Rate = k [NO]⁴[H₂]³**

c. **Rate = k [NO]³[H₂]⁴**

d. **Rate = k [NO][H₂]**

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

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

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	M ⁻¹ s ⁻¹	M ⁻² s ⁻¹	M ⁻³ s ⁻¹
	s ⁻¹	L/(mol.s)	L ² /(mol ² .s)	L ³ /(mol ³ .s)
rate unit	mol/(L.s)			

specific rate constant **k**

Unique for each reaction

has different units of measurement

does not change with concentration

changes with temperature

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

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

a. s⁻¹

b. L²/(mol².s)

c. L³/(mol³.s)

d. L/(mol.s)