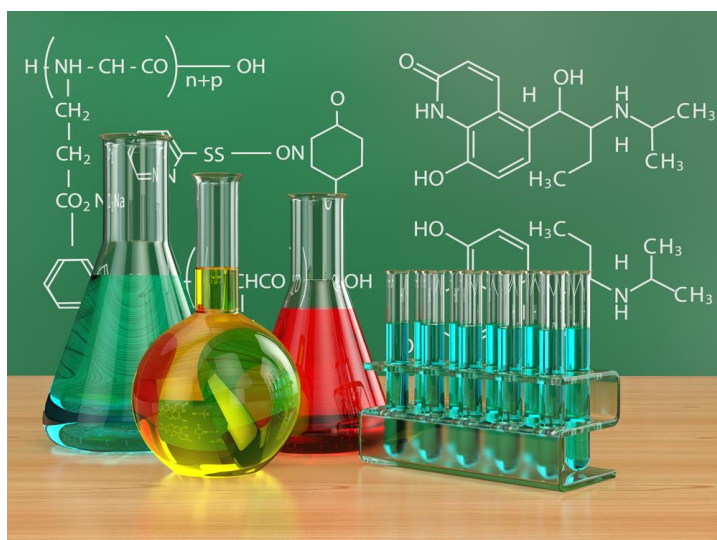


Chapter 7

Lattice Energy



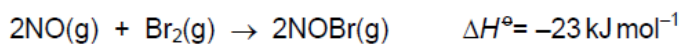
Mubashir Sulehri

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Roots International School
Lahore Learning Campus
Bloomfield Hall School
Green Hall Academy

1

Nitric oxide, NO, and bromine vapour react together according to the following equation.

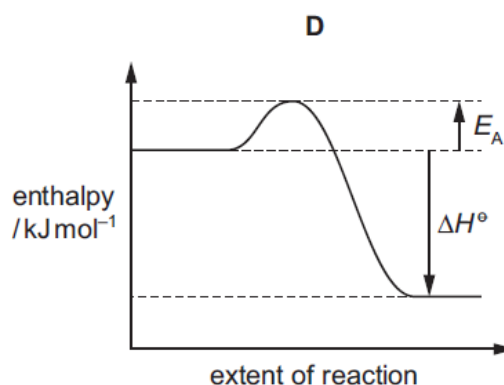
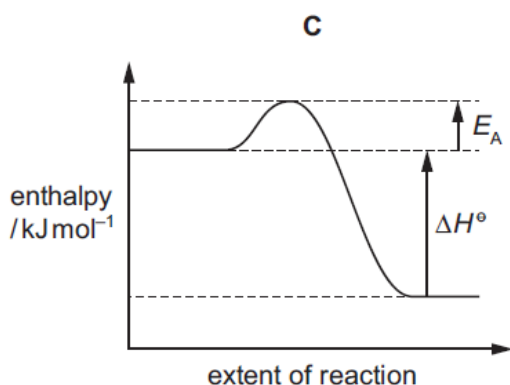
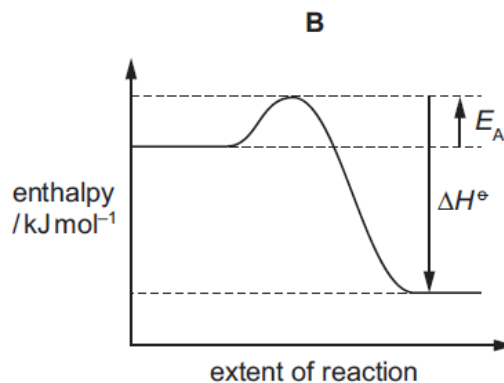
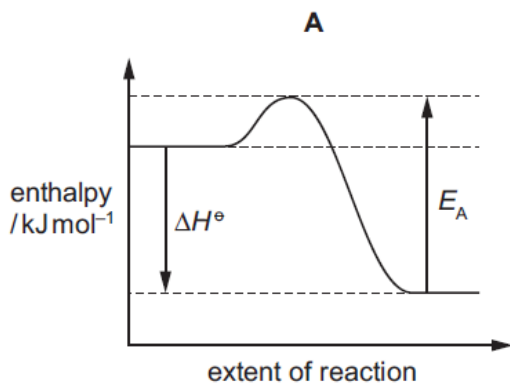


The reaction has an activation energy of $+5.4 \text{ kJ mol}^{-1}$.

What is the correct reaction pathway diagram for this reaction?

1

Mubashir Sulehri



D

2

Which equation has an enthalpy change of reaction which corresponds to the standard enthalpy change of atomisation of chlorine?

- A $\frac{1}{2} \text{Cl}_2(\text{g}) \rightarrow \text{Cl}(\text{g})$
- B $\frac{1}{2} \text{Cl}_2(\text{l}) \rightarrow \text{Cl}(\text{g})$
- C $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$
- D $\text{Cl}_2(\text{l}) \rightarrow 2\text{Cl}(\text{g})$

A

- 3 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating. The table below gives the bond energies.

bond	bond energy / kJ mol^{-1}
P-Cl (in both chlorides)	330
Cl-Cl	240

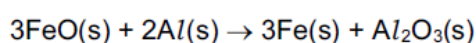
What is the enthalpy change in the decomposition of PCl_5 to PCl_3 and Cl_2 ?

- A -420 kJ mol^{-1} B -90 kJ mol^{-1} C $+90 \text{ kJ mol}^{-1}$ D $+420 \text{ kJ mol}^{-1}$

D

- 4 The standard enthalpy changes of formation of iron(II) oxide, $\text{FeO}(\text{s})$, and aluminium oxide, $\text{Al}_2\text{O}_3(\text{s})$, are -266 kJ mol^{-1} and $-1676 \text{ kJ mol}^{-1}$ respectively.

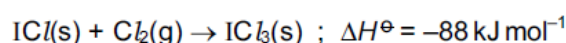
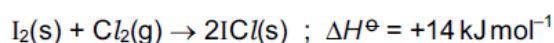
What is the enthalpy change under standard conditions for the following reaction?



- A $+878 \text{ kJ}$ B -878 kJ C -1942 kJ D -2474 kJ

B

- 5 Iodine trichloride, ICl_3 , is made by reacting iodine with chlorine.

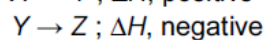


By using the data above, what is the enthalpy change of the formation for solid iodine trichloride?

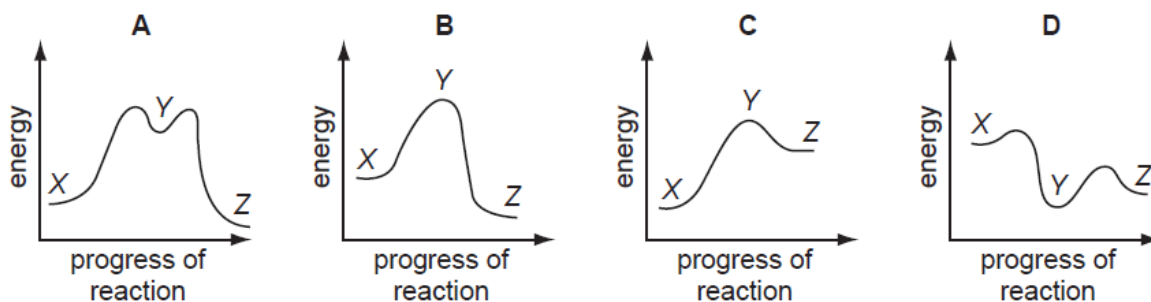
- A -60 kJ mol^{-1}
 B -74 kJ mol^{-1}
 C -81 kJ mol^{-1}
 D -162 kJ mol^{-1}

C

- 6 In the conversion of compound X into compound Z, it was found that the reaction proceeded by way of compound Y, which could be isolated. The following steps were involved.



Which reaction profile fits these data?



A

7 The gaseous oxides of nitrogen have positive enthalpy changes of formation.

Which factor is likely to make the most significant contribution to these enthalpy changes?

- A the high bond energy of the nitrogen molecule, N_2
- B the high electron affinity of nitrogen atoms
- C the high electron affinity of oxygen atoms
- D the similarity of the electronegativities of oxygen and nitrogen

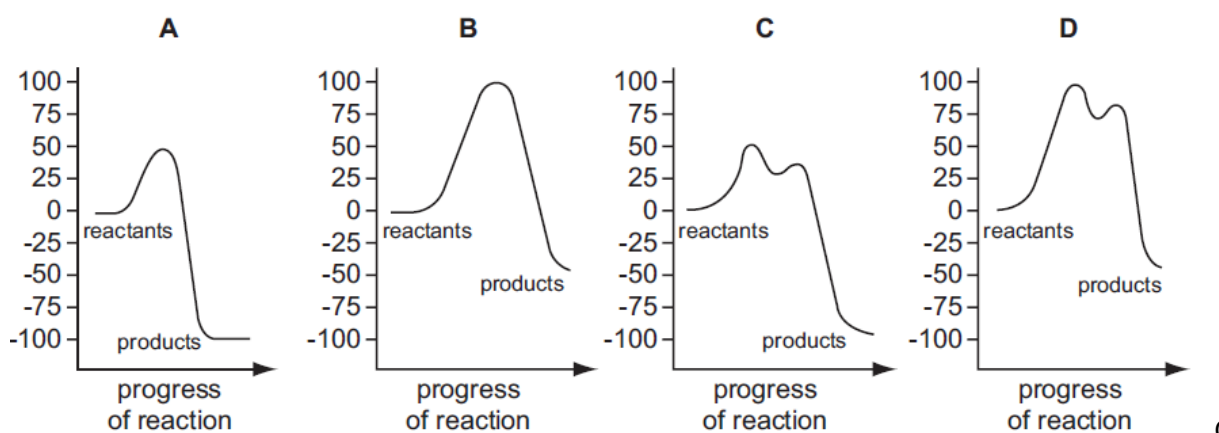
A

8 An exothermic chemical reaction proceeds by two stages.



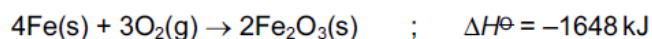
The activation energy of stage 1 is 50 kJ mol^{-1} . The overall enthalpy change of reaction is -100 kJ mol^{-1} .

Which diagram represents the reaction pathway for this reaction?



C

9 Skiers trapped by snowstorms use heat packs to keep warm. The heat may be generated by the reaction below.



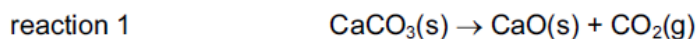
What is the standard enthalpy change of formation of iron(III) oxide?

- A 0 kJ mol^{-1}
- B -824 kJ mol^{-1}
- C $-1648 \text{ kJ mol}^{-1}$
- D $-3296 \text{ kJ mol}^{-1}$

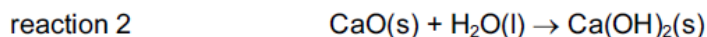
B

- 10 Slaked lime, Ca(OH)_2 , may be made from limestone, CaCO_3 .

On heating in a lime kiln at 1000°C , limestone decomposes as follows.



Water is then reacted with calcium oxide, CaO , as follows.



What are the enthalpy changes of these reactions?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

B

- 11 The standard enthalpy changes of formation of HCl and HI are -92 kJ mol^{-1} and $+26 \text{ kJ mol}^{-1}$ respectively.

Which statement is **most** important in explaining this difference?

- A Chlorine is more electronegative than iodine.
- B The activation energy for the H_2/Cl_2 reaction is much less than that for the H_2/I_2 reaction.
- C The bond energy of HI is smaller than the bond energy of HCl .
- D The bond energy of I_2 is smaller than the bond energy of Cl_2 .

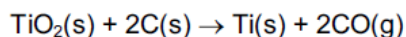
C

- 12 For which equation does the enthalpy change correspond to the enthalpy change of atomisation of iodine?

- A $\frac{1}{2}\text{I}_2(\text{s}) \rightarrow \text{I}(\text{s})$
- B $\frac{1}{2}\text{I}_2(\text{s}) \rightarrow \text{I}(\text{g})$
- C $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$
- D $\text{I}_2(\text{s}) \rightarrow 2\text{I}(\text{g})$

B

- 13 Titanium occurs naturally as the mineral rutile, TiO_2 . One possible method of extraction of titanium is to reduce the rutile by heating with carbon.



The standard enthalpy changes of formation of $\text{TiO}_2(\text{s})$ and $\text{CO}(\text{g})$ are -940 kJ mol^{-1} and -110 kJ mol^{-1} respectively.

What is the standard enthalpy change of this reaction?

- A -830 kJ mol^{-1}
- B -720 kJ mol^{-1}
- C $+720 \text{ kJ mol}^{-1}$
- D $+830 \text{ kJ mol}^{-1}$

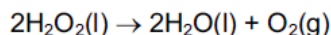
C

- 14 Hydrogen peroxide slowly decomposes into water and oxygen. The enthalpy change of reaction can be calculated using standard enthalpies of formation.

$$\Delta H_f^\ominus(\text{hydrogen peroxide(l)}) = -187.8 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\ominus(\text{water(l)}) = -285.8 \text{ kJ mol}^{-1}$$

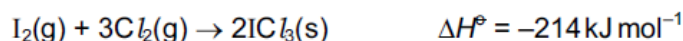
Using a Hess cycle, what is the enthalpy change of reaction for this decomposition?



- A +98 kJ mol⁻¹
 B -98 kJ mol⁻¹
 C -196 kJ mol⁻¹
 D -947.2 kJ mol⁻¹

C

- 15 Given the following enthalpy changes,

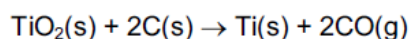


What is the standard enthalpy change of formation of iodine trichloride, ICl₃(s)?

- A +176 kJ mol⁻¹
 B -88 kJ mol⁻¹
 C -176 kJ mol⁻¹
 D -214 kJ mol⁻¹

B

- 16 Titanium occurs naturally as the mineral rutile, TiO₂. One possible method of extraction of titanium is to reduce the rutile by heating with carbon.



The standard enthalpy changes of formation of TiO₂(s) and CO(g) are -940 kJ mol⁻¹ and -110 kJ mol⁻¹ respectively.

What is the standard enthalpy change of this reaction?

- A -830 kJ mol⁻¹
 B -720 kJ mol⁻¹
 C +720 kJ mol⁻¹
 D +830 kJ mol⁻¹

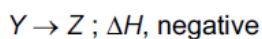
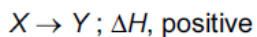
C

- 17 Which reaction has an enthalpy change equal to the standard enthalpy change of formation of propane?

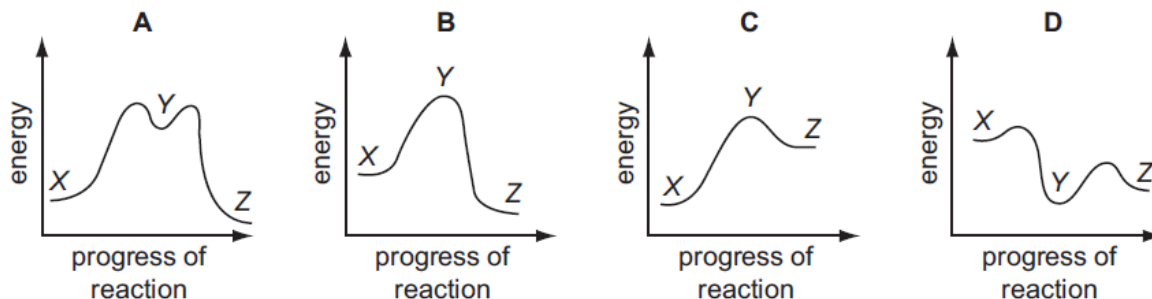
- A 3C(g) + 4H₂(g) → C₃H₈(g)
 B 3C(g) + 8H(g) → C₃H₈(g)
 C 3C(s) + 4H₂(g) → C₃H₈(g)
 D 3C(s) + 4H₂(g) → C₃H₈(l)

C

- 18 In the conversion of compound X into compound Z, it was found that the reaction proceeded by way of compound Y, which could be isolated. The following steps were involved.



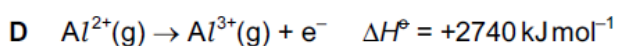
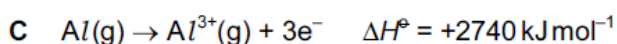
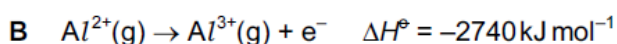
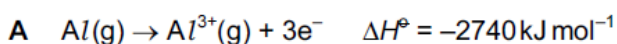
Which reaction profile fits these data?



A

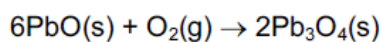
- 19 The value of the third ionisation energy of aluminium is 2740 kJ mol^{-1} .

Which correctly represents this statement?



D

- 20 Red lead oxide, Pb_3O_4 , is used in metal priming paints. It can be made by heating PbO in air.



Which two values are needed to calculate the enthalpy change for this reaction?

A enthalpy change of atomisation of O_2 and enthalpy change of formation of Pb_3O_4

B enthalpy change of formation of O_2 and enthalpy change of formation of Pb_3O_4

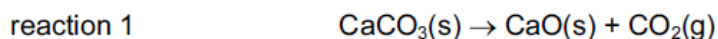
C enthalpy change of formation of PbO and enthalpy change of atomisation of O_2

D enthalpy change of formation of PbO and enthalpy change of formation of Pb_3O_4

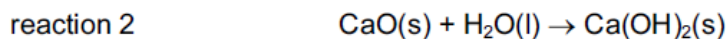
D

- 21 Slaked lime, Ca(OH)_2 , may be made from limestone, CaCO_3 .

On heating in a lime kiln at 1000°C , limestone decomposes as follows.



Water is then reacted with calcium oxide, CaO , as follows.



What are the enthalpy changes of these reactions?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

B

- 22 Use of the Data Booklet is relevant to this question.

A student mixed 25 cm^3 of 0.10 mol dm^{-3} sodium hydroxide solution with 25 cm^3 of 0.10 mol dm^{-3} hydrochloric acid and noted a temperature rise of 2.5°C .

What is the enthalpy change of the reaction per mole of NaOH ?

- A -209 kJ mol^{-1}
 B $-104.5\text{ kJ mol}^{-1}$
 C -209 J mol^{-1}
 D -522.5 J mol^{-1}

A

- 23 Which energy change corresponds to the enthalpy change of atomisation of hydrogen at 298 K ?

- A the bond energy of a H-H bond
 B half the bond energy of a H-H bond
 C minus half the bond energy of a H-H bond
 D minus the bond energy of a H-H bond

B

- 24 Propanone has molecular formula $\text{C}_3\text{H}_6\text{O}$.

The enthalpy change of combustion of hydrogen is -286 kJ mol^{-1} .

The enthalpy change of combustion of carbon is -394 kJ mol^{-1} .

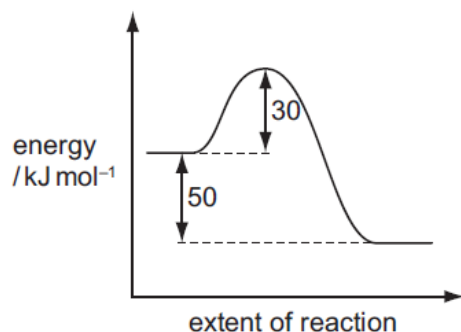
The enthalpy change of formation of propanone is -254 kJ mol^{-1} .

Using this information, what is the enthalpy change of combustion of propanone?

- A -2644 kJ mol^{-1}
 B -2294 kJ mol^{-1}
 C -1786 kJ mol^{-1}
 D -426 kJ mol^{-1}

C

- 25 The reaction pathway for a reversible reaction is shown below.



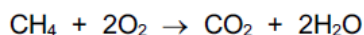
8

Mubashir Sulehri

Which statement is correct?

- A The activation energy of the reverse reaction is $+80 \text{ kJ mol}^{-1}$.
 B The enthalpy change for the forward reaction is $+30 \text{ kJ mol}^{-1}$.
 C The enthalpy change for the forward reaction is $+50 \text{ kJ mol}^{-1}$.
 D The enthalpy change for the reverse reaction is $+30 \text{ kJ mol}^{-1}$. A
- 26 *Use of the Data Booklet is relevant to this question.*

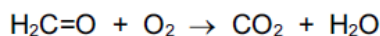
This question should be answered using bond enthalpy data. The equation for the complete combustion of methane is given below.



What is the enthalpy change of combustion of methane?

- A $-1530 \text{ kJ mol}^{-1}$
 B $-1184 \text{ kJ mol}^{-1}$
 C -770 kJ mol^{-1}
 D -688 kJ mol^{-1} D
- 27 *Use of the Data Booklet is relevant to this question.*

This question should be answered using bond enthalpy data. The equation for the complete combustion of methanal is given below.



What is the enthalpy change of combustion of methanal?

- A $+416 \text{ kJ mol}^{-1}$
 B $+396 \text{ kJ mol}^{-1}$
 C -344 kJ mol^{-1}
 D -690 kJ mol^{-1} C

- 28 The enthalpy change of formation of carbon dioxide is -394 kJ mol^{-1} .
The enthalpy change of formation of water is -286 kJ mol^{-1} .
The enthalpy change of formation of methane is -74 kJ mol^{-1} .

What is the enthalpy change of combustion of methane?

- A -892 kJ mol^{-1}
B -606 kJ mol^{-1}
C $+606 \text{ kJ mol}^{-1}$
D $+892 \text{ kJ mol}^{-1}$

A

- 29 Which equation represents the standard enthalpy change of formation of ethanol, $\text{C}_2\text{H}_5\text{OH}$?

- A $2\text{C}(\text{g}) + 3\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l})$
B $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l})$
C $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$
D $2\text{C}(\text{g}) + 6\text{H}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l})$

B

- 30 The diagram shows the skeletal formula of cyclopropane.



The enthalpy change of formation of cyclopropane is $+53.3 \text{ kJ mol}^{-1}$ and the enthalpy change of atomisation of graphite is $+717 \text{ kJ mol}^{-1}$.

The bond enthalpy of $\text{H}-\text{H}$ is 436 kJ mol^{-1} and of $\text{C}-\text{H}$ is 410 kJ mol^{-1} .

What value for the average bond enthalpy of the $\text{C}-\text{C}$ bond in cyclopropane can be calculated from this data?

- A 187 kJ mol^{-1} B 315 kJ mol^{-1} C 351 kJ mol^{-1} D 946 kJ mol^{-1}

B

- 31
32
33
34
35

Enthalpy Changes

1	D	11	C	21	B	31	
2	A	12	B	22	A	32	
3	D	13	C	23	B	33	
4	B	14	C	24	C	34	
5	C	15	B	25	A	35	
6	A	16	C	26	D	36	
7	A	17	C	27	C	37	
8	C	18	A	28	A	38	
9	B	19	D	29	B	39	
10	B	20	D	30	B	40	