HL Paper 1

Given the enthalpy change for the reaction below:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \quad \Delta H^{\ominus} = -572\ \text{kJ}$$

which statement is correct?

A. The standard enthalpy change of combustion of $H_2(g)$ is $-286\ \text{kJ mol}^{-1}$.

B. The standard enthalpy change of combustion of $H_2(g)$ is $+286\ \text{kJ mol}^{-1}$.

C. The standard enthalpy change of formation of $H_2O(l)$ is $-572\ \text{kJ mol}^{-1}$.

D. The standard enthalpy change of formation of $H_2O(l)$ is $+572\ \text{kJ mol}^{-1}$.

Consider the two reactions involving iron and oxygen.

$$2Fe(s) + O_2(g) \rightarrow 2FeO(s) \quad \Delta H^{\ominus} = -544\ \text{kJ}$$
$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H^{\ominus} = -1648\ \text{kJ}$$

What is the enthalpy change, in kJ, for the reaction below?

$$4FeO(s) + O_2(g) \rightarrow 2Fe_2O_3(s)$$

A. $-1648 - 2(-544)$

B. $-544 - (-1648)$

C. $-1648 - 544$

D. $-1648 - 2(544)$

Enthalpy changes of reaction are provided for the following reactions.

$$2C(s) + 2H_2(g) \rightarrow C_2H_4(g) \quad \Delta H^{\ominus} = +52\ \text{kJ mol}^{-1}$$
$$2C(s) + 3H_2(g) \rightarrow C_2H_6(g) \quad \Delta H^{\ominus} = -85\ \text{kJ mol}^{-1}$$

What is the enthalpy change, in kJ mol^{-1}, for the reaction between ethene and hydrogen?

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

A. –137

B. –33

C. +33

D. +137

The enthalpy change for the dissolution of NH_4NO_3 is +26 kJ mol^{-1} at 25 °C. Which statement about this reaction is correct?

A. The reaction is exothermic and the solubility decreases at higher temperature.

B. The reaction is exothermic and the solubility increases at higher temperature.

C. The reaction is endothermic and the solubility decreases at higher temperature.

D. The reaction is endothermic and the solubility increases at higher temperature.

Which equation represents the standard enthalpy of formation of liquid methanol?

A. $\mathrm{C(g) + 2H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow CH_3OH(l)}$

B. $\mathrm{C(g) + 4H(g) + O(g) \rightarrow CH_3OH(l)}$

C. $\mathrm{C(s) + 4H(g) + O(g) \rightarrow CH_3OH(l)}$

D. $\mathrm{C(s) + 2H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow CH_3OH(l)}$

Which reaction has an enthalpy change equal to the standard enthalpy change of combustion?

A. $\mathrm{C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)}$

B. $\mathrm{C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)}$

C. $\mathrm{2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)}$

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

Which process is endothermic?

A. $\mathrm{2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)}$

B. $\mathrm{Na(g) \rightarrow Na^+(g) + e^-}$

C. $\mathrm{H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)}$

D. $\mathrm{NH_3(g) \rightarrow NH_3(l)}$

Which equation represents the bond enthalpy for the H–Br bond in hydrogen bromide?

A. $\mathrm{HBr(g) \rightarrow H(g) + Br(g)}$

B. $\mathrm{HBr(g) \rightarrow H(g) + Br(l)}$

C. $\mathrm{HBr(g) \rightarrow H(g) + \tfrac{1}{2}Br_2(l)}$

D. $\mathrm{HBr(g) \rightarrow H(g) + \tfrac{1}{2}Br_2(g)}$

The same amount of heat energy is added to 1.00 g of each substance.

Substance	Specific heat capacity / $J g^{-1} K^{-1}$
Copper	0.39
Aluminium	0.90
Sodium chloride	0.90
Water	4.18

Which statement is correct if all the substances are at the same temperature before the heat energy is added?

A. Copper will reach the highest temperature.

B. Water will reach the highest temperature.

C. All four substances will reach the same temperature.

D. Aluminium will reach a higher temperature than sodium chloride.

1.0 g of sodium hydroxide, NaOH, was added to 99.0 g of water. The temperature of the solution increased from 18.0 °C to 20.5 °C. The specific heat capacity of the solution is $4.18\ \mathrm{J\,g^{-1}K^{-1}}$. Which expression gives the heat evolved in $\mathrm{kJ\ mol^{-1}}$?

A. $\frac{2.5\times100.0\times4.18\times1000}{40.0}$

B. $\frac{2.5\times100.0\times4.18}{1000\times40.0}$

C. $\frac{2.5\times100.0\times4.18\times40.0}{1000}$

D. $\frac{2.5\times1.0\times4.18\times40.0}{1000}$

Consider the equations below.

$$\begin{aligned}
&\mathrm{CH_4(g) + O_2(g) \rightarrow HCHO(l) + H_2O(l)} && \Delta H^{\ominus} = x \\
&\mathrm{HCHO(l) + \tfrac{1}{2}O_2(g) \rightarrow HCOOH(l)} && \Delta H^{\ominus} = y \\
&\mathrm{2HCOOH(l) + \tfrac{1}{2}O_2(g) \rightarrow (COOH)_2(s) + H_2O(l)} && \Delta H^{\ominus} = z
\end{aligned}$$

What is the enthalpy change of the reaction below?

$$\mathrm{2CH_4(g) + 3\frac{1}{2}O_2(g) \rightarrow (COOH)_2(s) + 3H_2O(l)}$$

A. $x + y + z$

B. $2x + y + z$

C. $2x + 2y + z$

D. $2x + 2y + 2z$

Which processes are exothermic?

I. $\mathrm{CH_3CH_2CH_3(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)}$

II. $\mathrm{Cl_2(g) \rightarrow 2Cl(g)}$

III. $\mathrm{CH_3CH_2COOH(aq) + NaOH(aq) \rightarrow CH_3CH_2COONa(aq) + H_2O(l)}$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which equation represents the standard enthalpy change of formation, ΔH_f^{Θ}, of tetrachloromethane?

A. $\mathrm{C(g) + 4Cl(g) \rightarrow CCl_4(g)}$

B. $\mathrm{C(s) + 4Cl(g) \rightarrow CCl_4(l)}$

C. $\mathrm{C(g) + 2Cl_2(g) \rightarrow CCl_4(g)}$

D. $\mathrm{C(s) + 2Cl_2(g) \rightarrow CCl_4(l)}$

Consider the following two equations.

$\mathrm{2Ca(s) + O_2(g) \rightarrow 2CaO(s)} \quad \Delta H^{\Theta} = +x\ \mathrm{kJ}$

$\mathrm{Ca(s) + 0.5O_2(g) + CO_2(g) \rightarrow CaCO_3(s)} \quad \Delta H^{\Theta} = +y\ \mathrm{kJ}$

What is ΔH^{Θ}, in kJ, for the following reaction?

$$\mathrm{CaO(s) + CO_2(g) \rightarrow CaCO_3(s)}$$

A. $y - 0.5x$

B. $y - x$

C. $0.5 - y$

D. $x - y$

Which ionic compound has the most endothermic lattice enthalpy?

A. Sodium chloride

B. Sodium oxide

C. Magnesium chloride

D. Magnesium oxide

The combustion of glucose is exothermic and occurs according to the following equation:

$$C_6H_{12}O_6\,(s) + 6O_2\,(g) \rightarrow 6CO_2\,(g) + 6H_2O\,(g)$$

Which is correct for this reaction?

	$\Delta H^{\ominus}$	$\Delta S^{\ominus}$	Spontaneous/ non-spontaneous
A.	negative	positive	spontaneous
B.	negative	positive	non-spontaneous
C.	positive	negative	spontaneous
D.	positive	positive	non-spontaneous

The equation for the formation of ethyne is:

$$2C(s) + H_2\,(g) \rightarrow C_2H_2\,(g)$$

What is the enthalpy change, in kJ, for this reaction using the enthalpy of combustion data below?

Reaction	ΔH° / kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$	–394
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	–572
$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l)$	–2602

A. $2 \times (-394) + \frac{1}{2}(-572) - \frac{1}{2}(-2602)$
B. $2 \times (-394) + (-572) - (-2602)$
C. $2 \times (-394) + \frac{1}{2}(-572) + \frac{1}{2}(-2602)$
D. $2 \times (-394) + (-572) + (-2602)$
