551534 – Chemistry
Group 02 Pretest 4.2

1 Experiments show that pure water at 25°C will dissociate as follows:

$$H_2O_{(l)} \leftrightarrow H^+_{(aq)} + OH^-_{(aq)}$$

Which of the following correctly defines $[H^+]$ and $[OH^-]$?

A) $[H^+] = 7$ mol/L $[OH^-] = 7$ mol/L

B) $[H^+] = 14$ mol/L $[OH^-] = 1$ mol/L

C) $[H^+] = 1 \times 10^{-14}$ mol/L $[OH^-] = 1 \times 10^{-1}$ mol/L

D) $[H^+] = 1 \times 10^{-7}$ mol/L $[OH^-] = 1 \times 10^{-7}$ mol/L

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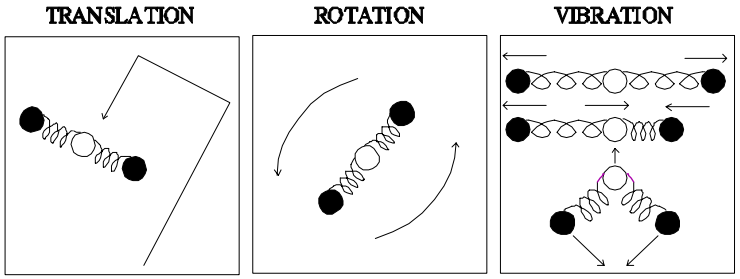
3 The following illustrations represent the types of motion exhibited by the different phases of matter.



A block of solid carbon dioxide (dry ice) is heated from -90°C to -70°C.

What **new** molecular motion is produced?

(N.B. : Carbon dioxide sublimes at -78.5°C at standard atmospheric pressure.)

A) Translational motion

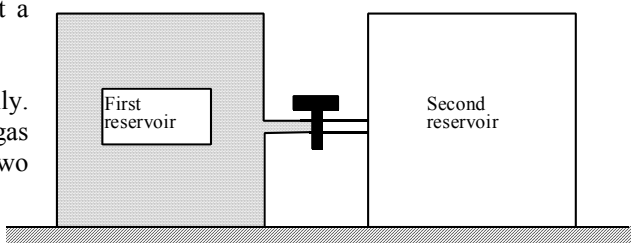
B) Translation and rotation motion

C) Translation, rotation and vibration motion

D) No new motion

4 The first reservoir has a volume of 500 litres. It is filled with gas at a pressure of 510 kPa and a temperature of 20°C.

The second reservoir has a volume of 250 litres and is empty initially. When the valve in the tube connecting the two reservoirs is opened, the gas enters the second reservoir and the temperature of the gas in the two reservoirs drops to 10°C.



What will be the new pressure of the gas in the two reservoirs?

A) 170 kPa

B) 265 kPa

C) 328 kPa

D) 383 kPa

5 Calculate the heat of combustion for ethane (C_2H_6) using the heat of formation reactions provided below:

1) $C + O_2 \longrightarrow CO_2$ $\Delta H = -393$ kJ
2) $2\ H_2 + O_2 \longrightarrow 2\ H_2O$ $\Delta H = -483$ kJ
3) $3\ H_2 + 2\ C \longrightarrow C_2H_6$ $\Delta H = -84$ kJ

The equation for the combustion of ethane is:

$$2\ C_2H_6 + 7\ O_2 \longrightarrow 4\ CO_2 + 6\ H_2O$$

Which of the following correctly identifies the heat of combustion for ethane (C_2H_6)?

A) -1035 kJ

B) -2853 kJ

C) -3189 kJ

D) -3819 kJ

6 A balloon is filled with an ideal gas and the initial pressure is recorded. Then, the absolute temperature is tripled, the volume is tripled, and the number of molecules is also tripled.

Which of the following best describes the final pressure of the gas?

A) The final pressure is 3 times higher.

B) The final pressure is 9 times higher.

C) The final pressure is 9 times lower.

D) The final pressure is 27 times higher.

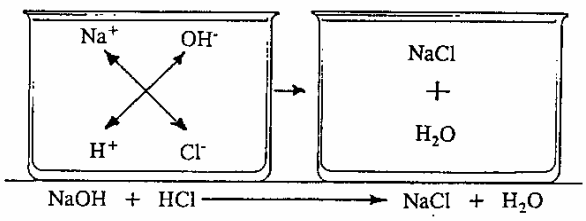
7 The following statements concern the enthalpy of substances :

1. When a chemical bond forms, the enthalpy decreases.
2. When a chemical bond is broken, the enthalpy decreases.
3. When a chemical bond is broken, the enthalpy increases.
4. When a chemical bond forms, the enthalpy increases.

Which of the statements are true?

A) 1 and 3
B) 1 and 4
C) 2 and 3
D) 2 and 4

8 When an acidic solution comes in contact with a basic solution, the hydrogen ions combine with the hydroxide ions, producing water. Also, the metallic ions combine with the non-metallic ions, producing a salt, as in the diagram below :



Given that the neutralizing reaction described above releases heat, which of the following statements is **correct**?

A) The enthalpy of the reactants is greater than the enthalpy of the products.
B) The enthalpy of the reactants is less than the enthalpy of the products.
C) The change in enthalpy (ΔH) is positive.
D) The reaction is endothermic.

9 The molar heat of reactions of various elements are listed below :

Elements			Formula	Name	ΔH/kJ
$H_{2(g)} + 1/2\ O_{2(g)}$	$\rightarrow$	$H_2O_{(g)}$		water vapour	-241.8
$1/8\ S_{8(s)} + O_{2(g)}$	$\rightarrow$	$SO_{2(g)}$		sulfur dioxide	-296.9
$H_{2(g)} + 1/8\ S_{8(s)} + 2O_{2(g)}$	$\rightarrow$	$H_2SO_{4(l)}$		sulfuric acid	-811.4
$C_{(s)} + 1/2\ O_{2(g)}$	$\rightarrow$	$CO_{(g)}$		carbon monoxide	-110.5
$C_{(s)} + O_{2(g)}$	$\rightarrow$	$CO_{2(g)}$		carbon dioxide	-393.5
$C_{(s)} + 2\ H_{2(g)}$	$\rightarrow$	$CH_{4(g)}$		methane	- 74.8
$2\ C_{(s)} + 3\ H_{2(g)}$	$\rightarrow$	$C_2H_{6(g)}$		ethane	- 84.7
$3\ C_{(s)} + 4\ H_{2(g)}$	$\rightarrow$	$C_3H_{8(g)}$		propane	-103.8

The following equation can be used to represent methane combustion :

$$CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}$$

What is the molar heat of methane combustion (CH_4)?

Show all you work.

10 Carbonic acid, H_2CO_3, is a weak acid. The dissociation of carbonic acid and the ionization constant, K_a, are shown below.

$$H_2CO_{3(aq)} \leftrightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)} \qquad K_a = 4.3 \times 10^{-7}$$

A chemistry student places 3.1×10^{-2} grams of carbonic acid into 5.0×10^2 mL of distilled water.

What is the pH of this solution?

11 Since the molar heat of formation of methanol, CH_3OH, from its elements cannot easily be measured, chemists prefer to calculate this value using the following thermochemical equations :

$$CH_3OH_{(l)} + \frac{3}{2}\ O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)} \qquad \Delta H = -726 \text{ kJ}$$

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -393 \text{ kJ}$$

$$H_{2(g)} + \frac{1}{2}\ O_{2(g)} \rightarrow H_2O_{(g)} \qquad \Delta H = -242 \text{ kJ}$$

The formation of methanol from its elements is represented by the following equation :

$$C_{(s)} + 2H_{2(g)} + \frac{1}{2}\ O_{2(g)} \rightarrow CH_3OH_{(l)}$$

Given this data, what is the molar heat of formation of methanol?

12 You wish to find the molar heat of combustion of calcium according to the following equation:

$$Ca_{(s)} + ½\ O_{2(g)} \rightarrow CaO_{(s)}$$

Because the results are difficult to obtain directly, you proceed by an indirect method. You carry out the two following experiments:

EXPERIMENT 1:

The reaction of 4.0 g of calcium with 1000 g of water according to the equation:

$$Ca_{(s)} + 2\ H_2O_{(l)} \rightarrow Ca^{2+}_{(aq)} + 2\ OH^-_{(aq)} + H_{2(g)}$$

Results:

Calcium	Water	Initial Temperature	Final Temperature
4 g	1000 g	19.0°C	29.3°C

EXPERIMENT 2:

The reaction of 5.6 g calcium oxide with 1000 g of water according to the equation:

$$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca^{2+}_{(aq)} + 2\ OH^-_{(aq)}$$

Results:

Calcium oxide	Water	Initial Temperature	Final Temperature
5.6 g	1000 g	21.0°C	22.9°C

Consulting your chemistry text, you then find the molar heat of combustion of hydrogen, H_2:

$$H_{2(g)} + ½\ O_{2(g)} \rightarrow H_2O_{(l)} + 286\ kJ$$

How can you determine the molar heat of combustion of calcium from the results that you have obtained?

Show all your work.