Table I Heats Of Reaction At 101.3 Kpa And 298 K

1 Given the balanced equation representing a reaction occurring at 101.3 kilopascals and 298 K:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$ + energy

What is the net amount of energy released when one mole of $H_2O(\ell)$ is produced?

(1) 241.8 kJ (3) 483.6 kJ

(2) 285.8 kJ (4) 571.6 kJ

2 At 101.3 kPa and 298 K, what is the total amount of heat released when one mole of aluminum oxide, $Al_2O_3(s)$, is formed from its elements?

(1) 393.5 kJ (3) 1676 kJ

(2) 837.8 kJ (4) 3351 kJ

3 According to Table I, which equation represents a change resulting in the greatest quantity of energy released?

(1) $2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$

(2) $2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$

(3) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

(4) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

4 Based on Table I, what is the ΔH value for the production of 1.00 mole of $NO_2(g)$ from its elements at 101.3 kPa and 298 K?

(1) +33.2 kJ (3) +132.8 kJ

(2) −33.2 kJ (4) −132.8 kJ

5 Based on Table I, which equation represents a reaction with the greatest difference between the potential energy of the products and the potential energy of the reactants?

(1) $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$

(3) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$

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

6 Based on Table I, which equation represents conservation of mass and energy?

(1) $CH_4(g) + O_2(g) + 890.4\ kJ \rightarrow CO_2(g) + H_2O(\ell)$

(2) $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(\ell) + 890.4\ kJ$

(3) $CH_4(g) + 2O_2(g) + 890.4\ kJ \rightarrow CO_2(g) + 2H_2O(\ell)$

(4) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell) + 890.4\ kJ$

Base your answers to questions 7 on the information below.

Ammonium chloride is dissolved in water to form a 0.10 M $NH_4Cl(aq)$ solution. This dissolving process is represented by the equation below.

$$NH_4Cl(s) + \text{heat} \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$$

7 State evidence that indicates the dissolving of ammonium chloride is an endothermic process.

Base your answers to questions 8 on the information below and on your knowledge of chemistry.

In a laboratory activity, each of four different masses of $KNO_3(s)$ is placed in a separate test tube that contains 10.0 grams of H_2O at 25°C.

When each sample is first placed in the water, the temperature of the mixture decreases. The mixture in each test tube is then stirred while it is heated in a hot water bath until all of the $KNO_3(s)$ is dissolved. The contents of each test tube are then cooled to the temperature at which KNO_3 crystals first reappear. The procedure is repeated until the recrystallization temperatures for each mixture are consistent, as shown in the table below.

Data Table for the Laboratory Activity

Mixture	Mass of KNO_3 (g)	Mass of H_2O (g)	Temperature of Recrystallization (°C)
1	4.0	10.0	24
2	5.0	10.0	32
3	7.5	10.0	45
4	10.0	10.0	58

8 Based on Table I, explain why there is a decrease in temperature when the $KNO_3(s)$ was first dissolved in the water.

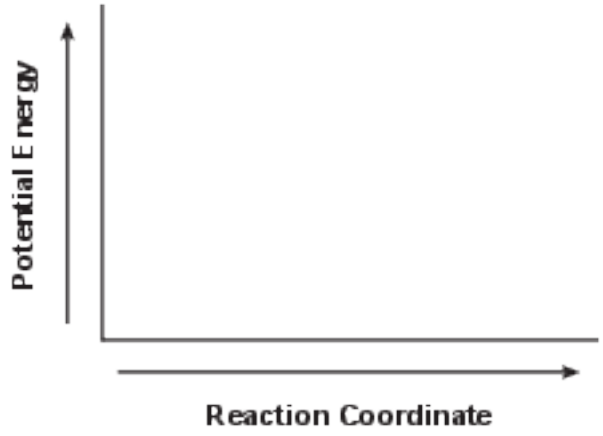
Base your answers to questions 9 on the information below and on your knowledge of chemistry.

In the early 1900s, scientists developed a process to produce ammonia from hydrogen and atmospheric nitrogen on an industrial scale. The balanced equation below represents this reaction.

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + 91.8\ kJ$

At room temperature, the reaction occurs at a very slow rate. Therefore, this process takes place in a special reaction vessel at high temperature and high pressure. A catalyst is used to increase the rate of the production of ammonia. The reaction gases are cooled to remove the ammonia as a liquid and the remaining gases are sent back to the reaction vessel.

9 Using the axes shown below, draw a potential energy diagram for the reaction. [1]



Base your answers to questions 10 on the information below and on your knowledge of chemistry.

During a laboratory activity, a student dissolves 20.0 grams of solid ammonium chloride, $NH_4Cl(s)$, in 100.0 grams of water at 25°C. After thorough stirring, no undissolved $NH_4Cl(s)$ remains. During this laboratory activity, appropriate safety equipment is used and safety procedures are followed.

10 State evidence from Table I that indicates that this dissolving process is endothermic. [1]

Base your answers to questions 11 on the information below and on your knowledge of chemistry.

Hydrogen gas and iodine gas can combine in a reversible reaction to form hydrogen iodide gas. The equation below represents this system at equilibrium in a sealed, rigid container.

$$H_2(g) + I_2(g) + 53.0\ kJ \rightleftharpoons 2HI(g)$$

11 State evidence from the equation that the forward reaction is endothermic. [1]

Answer Keys

1 2

2 3

3 3

4 1

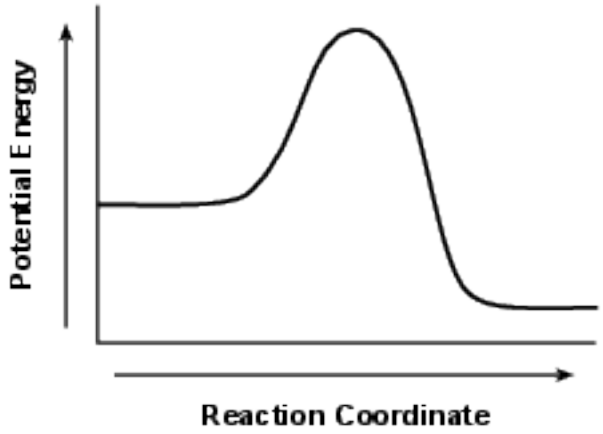
5 1

6 4

7 Allow 1 credit. Acceptable responses include, but are not limited to:
- The process requires heat to dissolve NH_4Cl.
- Energy is absorbed as NH_4Cl dissolves.
- The energy term is positive on the left side of the equation arrow.
- The heat of reaction is positive.

8 Allow 1 credit. Acceptable responses include, but are not limited to:
- The solution would decrease in temperature because the dissolving of $KNO_3(s)$ is endothermic.
- The heat of solution is positive, which means the mixture would decrease in temperature.
- The ΔH is + 34.89 kJ, so $KNO_3(s)$ requires energy to dissolve.

9 Allow 1 credit for showing that the PE of the products is lower than the PE of the reactants.
- Example of a 1-credit response:



10 Allow 1 credit. Acceptable responses include, but are not limited to:
- The nH for this dissolving is 114.78 kJ/mol.
- The heat of solution is positive.

11 Allow 1 credit. Acceptable responses include, but are not limited to:
- The equation shows energy on the reactant side.
- Energy is on the left side of the equation.
- The 53 kJ is on the left side.
- heat term on reactant side