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3-D ASSESSMENT

Thermochemistry

1. Based on collision theory, which of these features are characteristic of a successful reaction? Select all that apply.

A. a stable activated complex

B. a short-lived activated complex

C. correct orientation of colliding molecules

D. optimum temperature to provide sufficient energy

2. The bond enthalpy of the H-I bond is 295 kJ/mol. What is the ΔH value when the bonds in 0.5 mole of HI are broken?

A. −590 kJ

B. −147.5 kJ

C. +147.5 kJ

D. +590 kJ

3. Which statements are **true** about the representation of enthalpy for a thermochemical equation? Select all that apply.

A. On the product side, it is an exothermic reaction.

B. On the reactant side, it is an exothermic reaction.

C. On the product side, it is an endothermic reaction.

D. On the reactant side, it is an endothermic reaction.

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4. Describe the enthalpy diagram for the given reaction.

$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) \quad \Delta H = -65.2$ kJ

Is the reaction exothermic or endothermic? Explain your answer.

5. State Hess's law of constant heat summation and describe the main use of Hess's law.

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6. If the enthalpy of formation of water is −285.8 kJ/mol, what is the standard enthalpy for the reaction $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$?

A. −571.6 kJ

B. −285.8 kJ

C. 285.8 kJ

D. 571.6 kJ

7. Consider the reaction $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$. Use the three thermochemical equations to calculate the enthalpy of the reaction.

Equation 1: $CO_2(g) \rightarrow C(s) + O_2(g)$ $\Delta H = 393.5$ kJ

Equation 2: $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$ $\Delta H = -566.0$ kJ

Equation 3: $2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$ $\Delta H = 483.6$ kJ

Show the steps you use to calculate the enthalpy for the reaction.

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8. The chemical equation for the formation of NO_2 gas is shown.

$2NO + O_2 \rightleftharpoons 2NO_2$

The enthalpy of formation ΔH_f° NO is 90.37 kJ/mol and ΔH_f° NO_2 is 33.85 kJ/mol. What is the standard enthalpy for the reaction?

A. 0 kJ

B. 28.26 kJ

C. 56.52 kJ

D. 113.0 kJ

9. Hydrogen gas reacts explosively with chlorine gas to form gaseous hydrogen chloride. The chemical equation is shown.

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

The standard enthalpy of formation of HCl gas is −92.3 kJ/mol. Based on the chemical equation, what are the respective values for the standard enthalpy of the reaction and the standard enthalpy of formation of the reactants?

A. −184.6 kJ; 0 kJ

B. −92.3 kJ; 0 kJ

C. 0 kJ; −92.3 kJ

D. 0 kJ; −46.15 kJ

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Read the passage and use the table to answer the next two questions.

During the formation of a solution, heat is either released or absorbed. The table shows the known value when a specific number of moles of NaOH were dissolved in water.

Known	Value
ΔH_{soln}	–44.5 kJ/mol
Heat released into water when a certain number of moles of NaOH are dissolved in it	145.07 kJ

10. What statement **best** compares the energy change during the formation of solvation shells and the energy change during the breaking of ionic bonds and intermolecular forces for the given reaction?

A. energy released during formation of solvation shells < energy absorbed during breaking of bonds and intermolecular forces

B. energy released during formation of solvation shells > energy absorbed during breaking of bonds and intermolecular forces

C. energy absorbed during formation of solvation shells < energy released during breaking of bonds and intermolecular forces

D. energy absorbed during formation of solvation shells > energy released during breaking of bonds and intermolecular forces

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11. Use the table and the known values to calculate the number of moles of NaOH dissolved in water. Explain if heat is released or absorbed when NaOH is dissolved in water.

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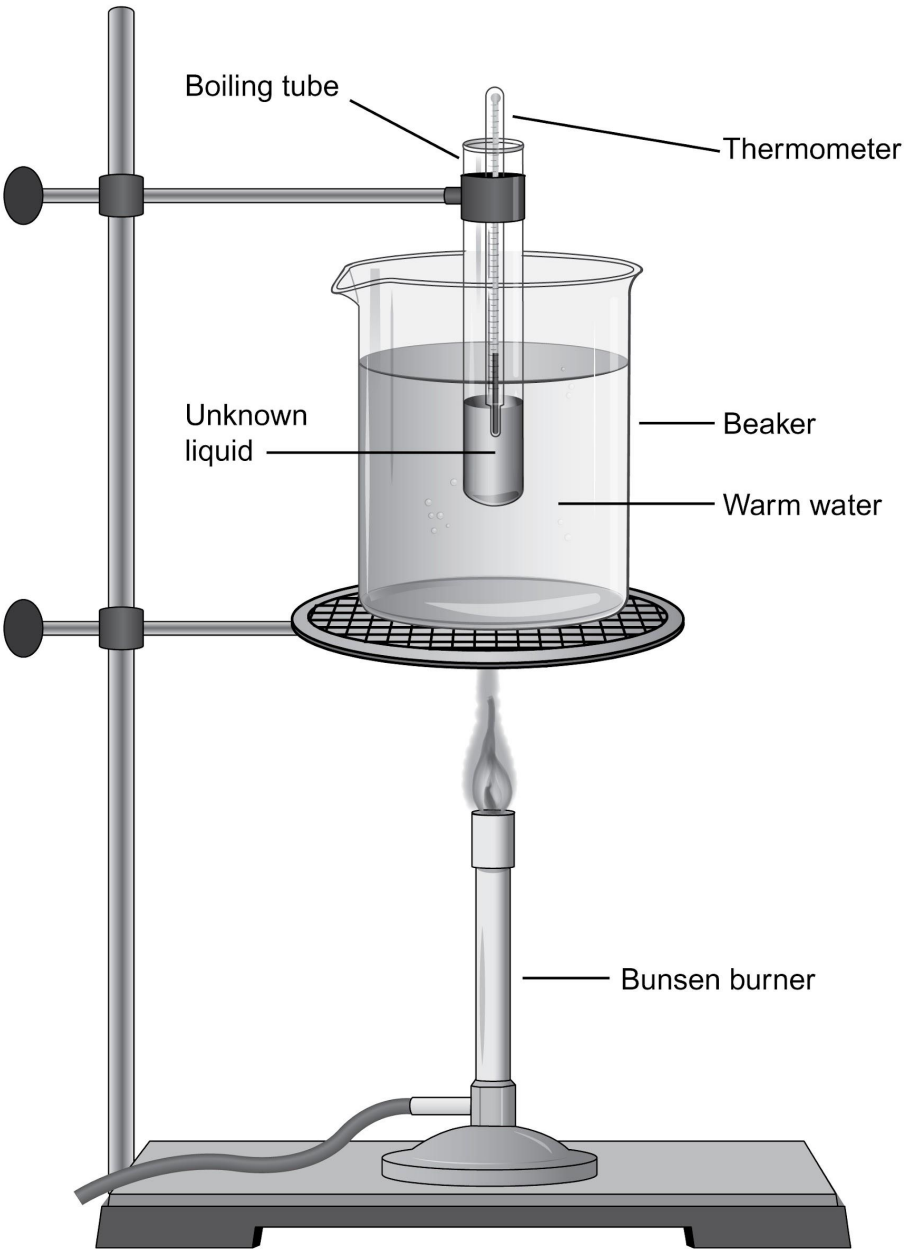
In this Performance Task, you will answer four questions.

During a lab activity, a group of students were assigned the task of establishing the identity of two unknown organic compounds: sample X and sample Y.

As part of the activity, a temperature probe was set up to determine the change in temperature of the samples over time. A Bunsen burner was used to gradually heat the water in the beaker. The setup of the experiment and the data collected for each unknown sample are shown.



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Lab Activity Data		
Time (s)	**Temperature (°C), Unknown Sample X**	**Temperature (°C), Unknown Sample Y**
0	30	30
10	37	39
20	44	47
30	44	55
40	44	65
50	44	68
60	50	68
70	55	68
80	70	68
90	82	79

12. The students plotted their data for each unknown sample on a graph. They observed that, for some time ranges, the segments of the graph line had a slope. For other time ranges, the segments were horizontal. Which time range will correspond to a sloped line on the graph? Select all that apply.

A. 0 s to 10 s; sample X

B. 60 s to 90 s; sample X

C. 50 s to 80 s; sample Y

D. 20s to 50 s; sample X

E. 0 s to 40 s; sample Y

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13. Based on the plotted data, the students explained the type of change taking place in the particles of sample X. Describe the change taking place in the particles of sample X from 20s to 50s and after 50s.

14. What are the melting points of sample X and Y? Based on the melting point comparison of sample X and sample Y, compare the strength of their intermolecular forces.

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15. The students compared the laboratory activity data with the melting points of some known organic compounds.

Melting Points of Known Organic Compounds

Organic Compound	Melting Point
Myristic Acid	54.0°C
Decanoic Acid	31.9°C
Lauric Acid	43.8°C
Stearic Acid	68.8°C
Palmitic Acid	63.0°C

Which compound is sample Y **most likely** to be?

A. decanoic acid

B. stearic acid

C. lauric acid

D. palmitic acid