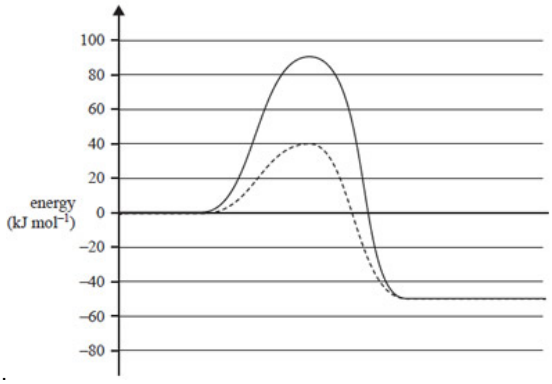
Thermochemistry (2018 VCE)

1) The energy profile diagram below represents a particular reaction. One graph represents the uncatalysed reaction and the other graph represents the catalysed reaction



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Which of the following best matches the energy profile diagram?

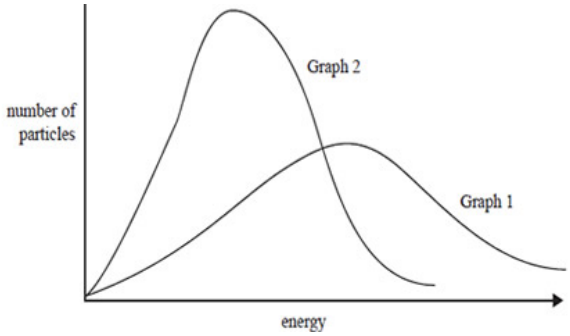
	E_a uncatalysed reaction (kJ mol^{-1})	ΔH catalysed reaction (kJ mol^{-1})
A.	40	–140
B.	90	–140
C.	40	–50
D.	90	–50

Solution

Solution will appear here

2) An equation for the complete combustion of methanol is
$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$
ΔH for this equation would be
A. +726 kJ mol^{-1}
B. –726 kJ mol^{-1}
C. +1452 kJ mol^{-1}
D. –1452 kJ mol^{-1}.
Solution

3) The kinetic energy of a sample of gas in a container of fixed volume is represented by the distribution curve shown in
Graph 1 below. One change was made to the sample and the resulting distribution curve of kinetic energy is shown in Graph 2.



Which one of the following statements explains the change from Graph 1 to Graph 2?
A. The average kinetic energy of the gas molecules decreased.
B. More gas, at the same temperature, was added to the container.
C. More collisions occurred between gas particles.
D. The temperature of the gas was increased.
Solution

4) The four equations below represent different equilibrium systems.

Equation 1	$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$	$\Delta H = -180$ kJ mol^{-1}
Equation 2	$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$	$\Delta H = -46$ kJ mol^{-1}
Equation 3	$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	$\Delta H = 93$ kJ mol^{-1}
Equation 4	$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$	$\Delta H = 205$ kJ mol^{-1}

After equilibrium was established in each system, the temperature was decreased and the pressure was increased.
In which equilibrium system would both changes result in an increase in yield?
A. Equation 1
B. Equation 2
C. Equation 3
D. Equation 4
Solution

Solution will appear here

5) The molar heat of combustion of pentan-1-ol, $C_5H_{11}OH$, is 3329 kJ mol^{-1}.
M($C_5H_{11}OH$) = 88.0 g mol^{-1}
The mass of $C_5H_{11}OH$, in tonnes, required to produce 10 800 MJ of energy is closest to
A. 0.0286
B. 0.286
C. 2.86
D. 286

Solution

6) Hydrogen peroxide, H_2O_2, in aqueous solution at room temperature decomposes slowly and irreversibly to
form water, H_2O, and oxygen, O_2, according to the following equation.
$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$ $\Delta H < 0$
a. What effect will increasing the temperature have on the rate of O_2 production? Use collision theory to explain your answer.

Solution

b) When a small lump of manganese(IV) dioxide, MnO_2, is added to the H_2O_2 solution, the rate of O_2 production increases, but when powdered MnO_2 is added instead, the rate of O_2 production is greatly increased. The MnO_2 is recovered at the end of the reaction. State the function of MnO_2 in this reaction.

Solution will appear here

Solution

c) A solution of $H_2O_2$is labelled '10 volume' because 1.00 L of this solution produces 10.0 L of O_2 measured at standard laboratory conditions (SLC) when the H_2O_2 in the solution is fully decomposed. Calculate the concentration of H_2O_2 in the '10 volume' solution, in grams per litre, when this solution is first prepared.

Solution

d) Propose a method to determine how quickly a solution of H_2O_2 decomposes when stored at a particular temperature.

Solution