What quantity of heat is released when 15.2 g of propane (C$_3$H$_8$) is burnt according to the following equation?

\[
C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + H_2O(l) \quad \Delta H = -2221 \text{ kJ mol}^{-1}
\]
- Ascorbic acid (Vitamin C) is a monoprotic acid of formula C₆H₈O₆. Calculate the pH of a 0.10 M solution of ascorbic acid, given the $K_a$ of ascorbic acid is $8.0 \times 10^{-5}$ M.

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- Write equations to show what happens to a buffer solution containing equimolar amounts of C₆H₅CH₂COOH and C₆H₅CH₂COOK when:
  (a) $\text{H}_3\text{O}^+$ is added,  (b) $\text{OH}^-$ is added.

(a)  

(b)
How much heat is evolved when 907 g of ammonia is produced according to the following equation? (Assume the reaction occurs at constant pressure.)

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \quad \Delta H = -91.8 \text{ kJ mol}^{-1} \]

Answer:
Calculate the pH of a solution that is 0.010 M in benzoic acid, $C_6H_5COOH$, and 0.010 M in $C_6H_5CO_2Na$. The $K_a$ of benzoic acid is $6.4 \times 10^{-5}$ M.

Answer:

Would this solution make a good buffer system? Give reasons for your answer?

The gases NO$_2$ and N$_2$O$_4$ are in equilibrium according to the following equation.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \quad \Delta H = +57 \text{ kJ mol}^{-1}$$

In which direction will the reaction move when the following changes are made?

1. The pressure is increased by decreasing the volume.
2. The temperature is increased.
• Quinine is a natural product that has anti-malarial properties. It was originally extracted for therapeutic use from the bark of the cinchona tree, but is now synthesised by the pharmaceutical industry. Quinine is not very soluble in water and is generally administered as the more soluble hydrochloride salt (C_{20}H_{24}N_{2}O_{2}·HCl). The pK_a of this salt is 4.32. What is the pH of a 0.053 M solution of quinine hydrochloride?

Answer:

• Use chemical equations to illustrate how HPO_4^{2-}/H_2PO_4^- can act as a buffer.
For the reaction \(2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})\) at 25 °C

\[\Delta H^\circ = -198.4 \text{ kJ mol}^{-1}\] and \[\Delta S^\circ = -187.9 \text{ J K}^{-1} \text{ mol}^{-1}\]

Show that this reaction is spontaneous in the forward direction at 25 °C.

If the volume of the reaction system is increased at 25 °C, in which direction will the equilibrium move?

Calculate the value of the equilibrium constant, \(K_p\), at 25 °C.

Assuming \(\Delta H^\circ\) and \(\Delta S^\circ\) are independent of temperature, in which temperature range is the reaction non-spontaneous?

Answer:
The balanced equation for the complete oxidation of glucose to carbon dioxide and water is given below.

\[ C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \]

Calculate the mass of carbon dioxide produced by the complete oxidation of 1.00 g of glucose.

Answer:
• Glucose is a common food source. The net reaction for its metabolism in humans is:

\[ C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \]

Calculate \( \Delta H^\circ \) for this reaction given the following heats of formation.

\( \Delta H^\circ_f (C_6H_{12}O_6(s)) = -1274 \text{ kJ mol}^{-1}, \quad \Delta H^\circ_f (CO_2(g)) = -393 \text{ kJ mol}^{-1} \) and

\( \Delta H^\circ_f (H_2O(l)) = -285 \text{ kJ mol}^{-1} \)

Answer:

If the combustion of glucose is carried out in air, water is produced as a vapour. Calculate the \( \Delta H^\circ \) for the combustion of glucose in air given that

\[ H_2O(l) \rightarrow H_2O(g) \quad \Delta H^\circ = +44 \text{ kJ mol}^{-1} \]

Answer:

Will \( \Delta S \) be different for the two oxidation reactions? If so, how will it differ and why?
Butyric acid, CH₃CH₂CH₂COOH, is found in rancid butter and parmesan cheese. The pKₐ of butyric acid is 4.83.

(a) What is the pH of a 0.10 M water solution of butyric acid?

(b) Calculate the pH of the solution formed when 0.050 mol of NaOH(s) is added to 1.0 L of 0.10 M butyric acid.

(c) Using equations, comment on how the final solution in (b) will respond to additions of small amounts of acid or base in comparison to 1 L of water.
Consider the reaction of H$_2$(g) with I$_2$(g) at 298 K to give HI(g).

\[ \text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}) \quad K_p = 2.24 \]

If partial pressures of 0.20 atm of all three gases are mixed, in which direction will the reaction proceed?

Answer:

Calculate $\Delta G^\circ$ for this reaction at 298 K.

Answer: