Blood maintains a constant pH by means of a \( \text{H}_2\text{CO}_3/\text{HCO}_3^- \) buffer. It resists any change in pH because any excess \( \text{H}^+ \) or \( \text{OH}^- \) is consumed as follows:
\[
\text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}_2\text{CO}_3 \quad \text{or} \quad \text{H}_2\text{CO}_3 + \text{OH}^- \rightarrow \text{HCO}_3^- + \text{H}_2\text{O}
\]
The buffer is an equilibrium system:
\[
\text{H}^+ + \text{HCO}_3^- \rightleftharpoons \text{H}_2\text{CO}_3
\]
More \( \text{CO}_2 \) is produced, so it dissolves in the blood to increase the concentration of \( \text{H}_2\text{CO}_3 \). This in turn pushes the above equilibrium to the left and the \( [\text{H}^+] \) increases. The pH will therefore go down, but only slightly as the buffer system is highly effective.

Hyperventilation results in a decrease in the amount of \( \text{CO}_2 \) in the blood. This pushes the \( \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \) equilibrium to the left which in turn pushes the \( \text{H}^+ + \text{HCO}_3^- \rightleftharpoons \text{H}_2\text{CO}_3 \) equilibrium to the right to produce more \( \text{H}_2\text{CO}_3 \). The net effect is thus to lower \( [\text{H}^+] \) and cause a small increase in pH.
(The standard treatment for hyperventilation is to get the patient to breath into a paper bag and rebreathe the \( \text{CO}_2 \) he has exhaled.)

Liquid water is more dense than solid water (ice). When pressure is applied to the ice by the wire, it melts and gravity pulls the wire downwards through the liquid water. Once the pressure is removed the water refreezes above the wire. The speeds of the two processes are such that the wire slowly cuts through the block without the block falling apart.

Allotropes are different molecular forms of the same element.
white and red phosphorus (many other examples possible)
The covalent lattice network of diamond is very strong. There is a very large energy of activation to convert it to the more stable graphite form and this energy is not available under normal conditions.

\[
\begin{align*}
\text{II} & \quad 4 & 8 & \text{K}^+(\text{aq}), \quad [\text{Ni(CN)}_4]^2-(\text{aq}) \\
\text{III} & \quad 6 & 3 & [\text{Cr(NH}_3)_3\text{Cl}]^{2+}(\text{aq}), \quad \text{Cl}^-(\text{aq}) \\
\text{III} & \quad 6 & 6 & [\text{Co(en)}_3]^{3+}(\text{aq}), \quad \text{Br}^{-}(\text{aq})
\end{align*}
\]

0.021 M
\[
\text{pH} = 3.60 \quad \text{pOH} = 10.40
\]
• Al₂O₃ is amphoteric and will dissolve in concentrated NaOH solution.

\[
Al₂O₃(s) + 3H₂O(l) + 2OH^-(aq) \rightarrow 2[Al(OH)₄]^{−}(aq)
\]

Fe₂O₃ is a basic oxide and will not dissolve in concentrated NaOH solution. Physical methods (filtration, centrifugation, etc) can now be used to separate the solid containing the Fe from the solution containing the Al.

\[
2[Al(OH)₄]^{−}(aq) + 2CO₂(g) \rightarrow Al₂O₃(s) + 3H₂O(l) + 2HCO₃^{−}(aq)
\]

It is amphoteric and dissolves in strongly basic solutions.

2004-N-7

•

\[\text{CH₃CH₂CH₂}—\text{O}—\text{CH₂CH₃}\]

\[\text{Br}\]

\[\text{CH₃NH₃} \text{Cl}^{-}\]

\[\text{CH₃CH₂C—NHCH₃} + \text{CH₃NH₃} \text{Cl}^{-}\]
2004-N-8

\[(E)\]
\[\text{CH}_2\text{CHO} \quad \text{CH}_2\text{CH}_2\text{CH}═\text{CHCH}_3 \quad \text{CH}_3 \quad \text{H}\]

\[(S)\]
\[
\begin{array}{c}
\text{CH} \\
\text{OH} \\
\text{H}_3\text{C} \\
\text{H} \\
\text{CONH}_2 \\
\text{CH}_2\text{OH} \\
\end{array}
\]

\[(S)\text{-enantiomer}\]

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\[
\begin{array}{c}
\text{OC} \\
\text{H} \\
\text{CH}_2\text{CH}_3 \\
\text{H} \\
\text{OH} \\
\text{H} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

1. LiAlH$_4$ / dry ether
2. H$^\ominus$/ H$_2$O
\[
\begin{align*}
\text{CH}_3\text{C}^\text{Cl}\text{H} & \quad \rightarrow \quad \text{CH}_3\text{C}^\text{Cl}\text{O}^\text{-H} \\
\text{CH}_3\text{C}^\text{O}\text{H} & \quad \rightarrow \quad \text{CH}_3\text{C}^\text{O}\text{H} \\
\text{CH}_3\text{C}^\text{O}\text{H} & \quad \rightarrow \quad \text{CH}_3\text{C}^\text{O}\text{H} \\
\end{align*}
\]