

Lower Elementary



Chemistry

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Teacher's Notes for Lower Elementary Experiments

Acids and Bases

Experiment 1

Many acidic foods taste sour, while the basic foods are bitter. There are not many basic foods, but many household cleaners are base.

Experiment 2

Prepare the solutions ahead of time for the children. With the powdered substances, mix 5 mL of each with distilled water, as tap water will affect the reactions. Crush the aspirin tablet and mix it with the distilled water. Make sure to label each substance. Give the children the chart to fill out their predictions. Acids will turn the litmus red, while bases will turn the paper blue. Neutrals will have no affect on the paper.

Experiment 3

The solution of lemon juice will work the best because it is the most acidic. The copper from the pennies oxidizes and becomes tarnished. When the tarnished pennies are placed into an acidic solution, the acid reacts with the oxidation and cleans the pennies.

Experiment 4

The cup with the vinegar and salt will yield the shiniest pennies after the 10 minute observation. However, overnight, the cup with the Cola-Cola will produce the shiniest pennies of all. Soft drinks are very acidic.

Acid, Base, or Neutral Solutions

Name of solution	Prediction acid, base, neutral	What happened to the paper?	Actual acid, base, neutral
1. _____		<u>red</u>	
2. _____		<u>blue</u>	
3. _____			
4. _____			
5. _____			
6. _____			
7. _____			
8. _____			
9. _____			
10. _____			

Conclusion

Acid, Base, or Neutral Solutions

Name of solution	Prediction acid, base, neutral	What happened to the paper?	Actual acid, base, neutral
1. _____		<u>red</u>	
2. _____		<u>blue</u>	
3. _____			
4. _____			
5. _____			
6. _____			
7. _____			
8. _____			
9. _____			
10. _____			

Conclusion

Teacher's Notes for Chemical Changes

Lower Elementary Experiments

Experiment 1

The chemical change is indicated by a color change as well as an odor change. The vitamin C inhibits the change the most because it stops the air from reaching the fruit.

Experiment 2

The vinegar reacts with the copper and oxygen to oxidize. The clay does not allow the air to get to the copper, so this part of the penny will not oxidize.

Experiment 3

The raw potato contains the enzyme catalase. Enzymes are chemicals found in living cells. Their purpose is to speed up the breakdown of complex food chemicals into smaller, simpler, more usable parts. Catalase from the potato's cells causes the hydrogen peroxide to quickly break apart into water and oxygen gas.

Experiment 4

Milk is a mixture of liquids and very tiny particles that are spread throughout the liquid. Vinegar causes the small, undissolved particles to clump together, forming a solid called curd. The liquid portion is referred to as whey.

Teacher's notes on Physical Change Experiments

Lower Elementary

Experiment 1

The changes occur on the surface of the ice cube since that is the part that is exposed to the warmer air. So observations that should be noted are that the ice cube becomes more transparent as it melts. The energy involved is supplied by the warm air. Of course this is reversible by placing it back into the freezer, where there is also more energy transference.

Experiment 2

As the solution evaporates, there is a freeing of ions molecularly. This allows the solid to reform in the shape of crystals. The jar cannot be stirred or moved, as this will break the fragile, beginning crystals, and not allow them to grow on the string.

Experiment 3

The water is filtered as they pass through smaller and smaller particles. This is an efficient system, since the water can flow through the smaller layers, while the larger particles are being filtered by the larger layers on the top.

Experiment 4

A mixture is a combination of two or more substances that can be easily separated. The sum of the two separate substances will equal the weight of the initial mixture.

Teacher's Notes for States of Matter

Lower Elementary

Experiment 1

The rice and ping-pong ball are not the only states of matter. In this case, there is also air trapped inside the jar and between the rice grains. When the jar is shaken, the rice grains get closer together, and push the ping-pong ball up. No two pieces of matter can occupy the same space at the same time.

Experiment 2

Both the marbles and water are matter and cannot occupy the same space at the same time. The rise in the water level is equal to the volume of the marbles.

Experiment 3

The three states are that the wax is a solid, the melted wax is a liquid, and the smoke is a gas. The states change due to a change in temperature, both in the heating and cooling of the wax.

Experiment 4

The 250 mL of salt is not solid throughout, there are spaces in between. The water moves into these space and, therefore, the total volume is less than 500 mL.

Experiment 5

recipe for goop.

- 1/2 cup of cornstarch
- 1 cup of water
- food coloring
- zip-lock bag

Mix the water and coloring into the cornstarch and add extra water if necessary - the Goop should have a thick consistency. Goop is actually a colloid, a substance that is between a homogeneous mixture (a solution where the substances cannot be separated) and a heterogeneous mixture (substances can be separated out... as in pizza or salad). Glue is another type of colloid. This branch of study was initiated in approximately 1861 by Scottish scientist, Thomas Graham.

Experiment 6

A liquid's resistance to flow is known as its viscosity. Pushing harder on a viscous liquid actually makes the liquid resist more, because the "holes" in the liquid, when pressed, make it harder for the molecules to move. Changing the temperature by heating, will make the liquid less viscous, while cooling it, will make it more viscous. (As slow as molasses in January, would be a good example!)

Experiment 7

The heated water has more holes in it, even though the molecules in the liquid are more tightly connected. The sugar granules fit in between these holes.

Experiment 8

The carbon dioxide produced by the reaction is heavier than air. The gas is invisible and will extinguish the flame. Carbon dioxide is also used as foam in fire extinguishers.

Experiment 9

The molecules in the air are pressing against the bag. These molecules are pressing out, more than the student is pressing in. Therefore, the bag exhibits resistance.

Experiment 10

The bottle is filled with air. Blowing into the balloon causes the molecules inside the bottle to move only slightly. There isn't enough room for the balloon to inflate.

Experiment 11

The glass is filled with paper and air. The paper did not get wet because the air prevented the water from entering the glass.

Experiment 12

When you blow into the bottle, the air pressure becomes unequal. There is also a slight vacuum at the neck of the bottle. As the pressure is equalized, the ball of paper is driven out.

CHEMICAL	STORE	PRODUCT
Acetic acid	Supermarket	Vinegar
Acetone	Drug store/hardware	Fingernail polish remover/paint solvent
Alcohol		
Ethanol	Hardware	Denatured alcohol
Isopropanol	Drugstore	Rubbing alcohol
Methanol	Hardware/Auto supply	Paint thinner/Gas line antifreeze
Antacid tablets	Drugstore	Any antacid tablets
Aluminum	Hardware/Craft Store	Wire, siding nails, flashing
Bobby pins	Drugstore	Metal bobby pins
Butane lighter	Supermarket/Drugstore	Butane lighter
Citric acid	Supermarket	Gatorade/Crystal Light
Copper	Hardware/Craft Store	Wire/Strips
Cornstarch	Supermarket	Any brand
Corn Syrup	Supermarket	Any brand
Cream of tartar	Supermarket	Any brand
Dishwashing liquid	Supermarket	Any brand
Gelatin dessert	Supermarket	Jell-O (citric flavors)
Glycerin	Drugstore	By name
Guar gum	Health food store	Any brand
Hydrochloric acid (HCl)	Hardware	Muriatic acid
Iodine	Drugstore	By name
Lead	Sporting Goods	Sinkers
Lighter fluid	Drugstore	By name
Magnesium	Sporting Goods	Light-weight frame Light-weight packframes
Oxalic acid	Auto supply	Radiator cleaner
Oils	Supermarket/Auto Supply/Drug-store	Cooking oils/Motor oils/Baby oil and Mineral oil
Paradichlorobenzene	Supermarket	Mothballs
pH indicator strips	Pet supply/Swimming pool supply	By name
Plaster of Paris	Hardware	By name
Powdered sugar	Supermarket	By name
Sodium Bicarbonate	Supermarket	Baking soda
Sodium Borate	Supermarket	Borax
Sodium Hydroxide	Supermarket	Drain cleaner
Sodium thiosulfate	Photography Store	Fixer, hypo
Sugar	Supermarket	By name
Waterless hand cleaner	Auto Supply	By name
White Glue	Craft Store/Supermarket	By name
Xylene	Hardware	Thinner/solvent
Zinc	Hardware	Hot-dipped galvanized nails

List of Notable Chemists

A

- Emil Abderhalden, (1877–1950), Swiss chemist
- Richard Abegg, (1869–1910), German chemist
- Peter Agre, (1949–), American chemist and doctor, 2003 Nobel Prize in Chemistry
- Arthur Aikin, (1773–1855), English chemist and mineralogist
- Johan August Arfwedson, (1792–1841), Swedish chemist
- Amedeo Avogadro, (1776–1856), Italian physicist

B

- Neil Bartlett, (born 1932), English/Canadian/American chemist
- Sir Derek Barton, (1918–1998), 1969 Nobel Prize in Chemistry
- Antoine Baum, (1728–1804), French chemist
- Claude Louis Berthollet, (1748–1822), French chemist
- Jöns Jakob Berzelius, (1779–1848), Swedish chemist
- Joseph Black, (1728–1799), chemist
- Dale L. Boger, (born 1953), American organic and medicinal chemist
- Carl Bosch, (1872–1940), German chemist
- Robert Boyle, (1627–1691), Irish pioneer of modern chemistry
- Johannes Nicolaus Brønsted, (1879–1947), Danish chemist
- Henri Braconnot, (1780–1855), French chemist and pharmacist
- Robert Wilhelm Bunsen, (1811–1899), German inventor, chemist
- Eduard Buchner, (1860–1917), 1907 Nobel Prize in Chemistry

C

- Melvin Calvin, (1911–1997), American chemist, winner of 1961 Nobel Prize in Chemistry
- Georg Ludwig Carius, (1829–1875), German chemist

- Heinrich Caro, (1834–1910), German chemist
- Wallace Carothers, (1896–1937), American chemist
- Henry Cavendish, (1731–1810), British scientist
- Yves Chauvin, (born 1930), 2005 Nobel Prize in Chemistry
- Elias James Corey, (born 1928), American organic chemist, winner of 1990 Nobel Prize in Chemistry
- Marie Curie, (1867–1934), Polish-born French radiation physicist, 1903 Nobel Prize in Physics
- Pierre Curie, (1859–1906), 1903 Nobel Prize in Physics
- Robert Curl, (born 1933), winner of 1996 Nobel Prize in Chemistry
- Theodor Curtius, (1857–1928), German chemist



- John Dalton, (1766–1844), physicist
- Carl Peter Henrik Dam, (1895–1976), Danish biochemist, winner of the 1943 Nobel Prize in Physiology or Medicine
- Humphry Davy, (1778–1829)
- Peter Debye, (1884–1966)
- Sir James Dewar, (1842–1923)
- François Diederich, (born 1952), Luxembourg chemist
- Otto Diels, (1876–1954), German chemist, winner of the 1950 Nobel Prize in Chemistry
- Edward Doisy, (born 1893), American biochemist, winner of the 1943 Nobel Prize in Physiology or Medicine
- Davorin Dolar, (1921-2005), chemist from Univ. of Ljubljana
- Emmanuel Dongala, Congolese chemist and novelist
- Jean Baptiste Dumas, (1800–1884), French chemist



- Paul Ehrlich, (1854–1915), German chemist, winner of the 1908 Nobel Prize in Physiology or Medicine
- Manfred Eigen, (born 1927), German chemist, winner of the 1967 Nobel Prize in Chemistry

- Arthur Eichengrün, (1867–1949)
- Emil Erlenmeyer, (1825–1909), German chemist
- Richard R. Ernst, (born 1933), 1991 Nobel Prize in Chemistry
- Hans von Euler-Chelpin, (1873–1964), Swedish chemist, winner of the 1929 Nobel Prize in Chemistry



- Michael Faraday (1791–1867), scientist
- Hermann Emil Fischer (1852–1919), 1902 Nobel Prize in Chemistry, not to be confused with:
- Franz Joseph Emil Fischer
- Ernst Gottfried Fischer (1754–1831), German chemist
- Hans Fischer (1881–1945), German organic chemist, 1930 Nobel Prize in Chemistry winner
- Nicolas Flamel, French alchemist
- Rosalind Franklin (1920–1958), British chemist and crystallographer
- Carl Remigius Fresenius (1818–1897), German chemist
- Wilhelm Fresenius (1913–2004), German chemist, great-grandson of Carl
- Alexander Naumovich Frumkin, (1895–1976), electrochemist



- Johan Gadolin, (1760–1852), Finnish chemist
- Merrill Garnett, (born 1930), American biochemist
- Victor Goldschmidt, (1888–1947) Father of Modern Geochemistry
- Ljubo Golic, (born 1932), chemist
- Thomas Graham, (1805–1869), not to be confused with:
- William Hardin Graham ???
- Francois Auguste Victor Grignard, (1871–1935), 1912 Nobel Prize in Chemistry corecipient
- Robert H. Grubbs, (born 1942), 2005 Nobel Prize in Chemistry

H

- Fritz Haber, (1868–1934) 1918 Nobel Prize in Chemistry
- Otto Hahn, (1879–1968) 1944 Nobel Prize in Chemistry
- John Haldane, (1860–1936), British biochemist
- Odd Hassel, (1897–1981), Norwegian chemist 1969 Nobel Prize in chemistry
- Charles Hatchett, (1765–1847), English chemist who discovered niobium
- Clayton Heathcock, American chemist
- Dudley R. Herschbach, (1932–), American chemist, 1986 Nobel Prize in Chemistry
- Charles Herty, American chemist
- Robert Havemann, (1910–1982), chemist
- George de Hevesy, (1885–1966), chemist, recipient of the 1943 Nobel Prize in Chemistry
- J. H. van 't Hoff, (1852–1911), Dutch physical chemist, 1901 Nobel Prize in Chemistry
- Friedrich Hoffmann, (1660–1742), physician and chemist
- Roald Hoffmann, (born 1937), Polish-born American chemist, 1981 Nobel Prize in Chemistry
- August Wilhelm von Hofmann, (1818–1892) German organic chemist
- Jaroslav Heyrovský, (1890–1967), Czech chemist, 1959 Nobel Prize in Chemistry
- Gerhard Herzberg, (1904–1999), German-Canadian chemist, 1971 Nobel Prize in Chemistry

I

- Sir Christopher Kelk Ingold (1893–1970), English chemist

J

- Frederic Joliot-Curie, (1900–1958), French chemist and physicist
- Irène Joliot-Curie, (1897–1956), French chemist and physicist

K

- Paul Karrer, (1889–1971), 1937 Nobel Prize in Chemistry

- Karl Wilhelm Gottlob Kastner, (1783–1857)
- Friedrich August Kekulé von Stradonitz, (1829–1896), German organic chemist
- Emil Knoevenagel, (1865–1921)
- Walter Kohn, (born 1923), 1998 Nobel Prize in Chemistry
- Adolph Wilhelm Hermann Kolbe, (1818–1884)
- Izaak Kolthoff, (1894–1993) the “Father of Analytical Chemistry”
- Aleksandra Kornhauser, (born 1926), chemist
- Harold Kroto, (born 1939), English chemist, 1996 Nobel Prize in Chemistry
- Richard Kuhn (1900–1967), 1938 Nobel Prize in Chemistry.



- Irving Langmuir, (1881–1957), chemist, physicist
- Antoine Lavoisier, (1743–1794), French pioneer chemist
- Eun Lee, (born 1946), Korean organic chemist
- Yuan T. Lee, (born 1936), winner of 1986 Nobel Prize in Chemistry
- Janez Levec, (born 1943), chemist
- Primo Levi, (1919–1987), resistance fighter, chemist and novelist
- Gilbert N. Lewis, (1875–1946), American chemist and first Dean of the Berkeley College of Chemistry
- Joseph Lister, 1st Baron Lister, (1827–1912), English surgeon
- Henri Louis le Chatelier, (1850–1936)
- Willard Libby, (1908–1980), American chemist, winner of 1960 Nobel Prize in Chemistry
- Justus von Liebig, (1803–1873), German inventor
- H. Christopher Longuet-Higgins, British Chemist
- Martin Lowry, (1874–1936), British chemist



- Vladimir Vasilevich Markovnikov, (1838–1904)
- Lise Meitner, (1878–1968), physicist

- Dmitri Ivanovich Mendeleev, (1834–1907), chemist, creator of the Periodic Table of Elements
- John Mercer, (1791–1866), chemist and industrialist
- Robert Bruce Merrifield, (1921–2006), solid-phase chemist
- Lothar Meyer, (1830–1895)
- Viktor Meyer, (1848–1897), not to be confused with :
- Kurt Heinrich Meyer
- Stanley Miller (born 1930), American chemist, best known for the Miller-Urey experiment
- Luis E. Miramontes, (1925–2004), co-inventor of the combined oral contraceptive pill
- William A. Mitchell, (1911–2004), key inventor behind Pop Rocks, Tang, and Kool Whip
- Alexander Mitscherlic, (1836–1918), chemist
- Jacques Monod, (1910–1976), biochemist, winner of 1965 Nobel Prize in Physiology or Medicine
- Peter Moore, (born 1939), American biochemist, Sterling Professor of Chemistry at Yale University
- Henry Gwyn Jeffreys Moseley, (1887-1915), English physicist, discovered Moseley's law.
- Robert S. Mulliken, (1896–1986), American physicist, chemist



- Robert Nalbandyan, (1937–2002), Armenian protein chemist
- Kyriacos Costa Nicolaou, American chemist
- Alfred Nobel, Swedish chemist



- George Andrew Olah, (born 1927), 1994 Nobel Prize in Chemistry
- Lars Onsager, (1903–1976), physical chemist, 1968 Nobel Prize in Chemistry
- Wilhelm Ostwald, (1853–1932), 1909 Nobel Prize in Chemistry



- Paracelsus, (1493–1541), alchemist
- Rudolph Pariser, (born 1923), theoretical and organic chemist

- Robert G. Parr, (born 1921), theoretical chemist
- Louis Pasteur, (1822–1895), French biochemist
- Linus Pauling, (1901–1994), Nobel Prizes in chemistry and peace
- William Perkin, (1838–1907) British organic chemist and inventor of mauveine (dye)
- John A. Pople, (1925–2004), theoretical chemist, 1998 Nobel Prize in Chemistry
- Roy J. Plunkett, (1910–1994), discoverer of Teflon
- Fritz Pregl, (1869–1930), chemist, 1923 Nobel Prize in Chemistry
- Vladimir Prelog, (1906–1998), 1975 Nobel Prize in Chemistry
- Joseph Priestley, (1733–1804)
- Ilya Prigogine, (1917–2003), 1977 Nobel Prize in Chemistry
- John Charles Polanyi, (born 1929), Canadian chemist, 1986 Nobel Prize in Chemistry



- Ğilem Qamay (1901–1970), Soviet chemist



- William Ramsay, (born 1852), Scottish chemist
- Henry Rapoport, American chemist, UC Berkeley
- Rhazes (Razi), (865–925)
- Julius Rebek, chemist
- Marij Rebek, chemist
- Henri Victor Regnault, (1810–1878), French chemist and physicist
- Tadeus Reichstein, (1897–1996), chemist, 1950 Nobel Prize in Physiology or Medicine
- Stuart A. Rice, (born 1932), physical chemist
- Ellen Swallow Richards, (1842–1911), industrial and environmental chemist
- Jeremias Benjamin Richter, (1762–1807), German chemist
- H. M. Rouell, (1718–1779)
- Leopold Ruzicka (Lavoslav Ružička) , (1887–1976), 1939 Nobel Prize in Chemistry



- Paul Sabatier, (1854–1941), 1912 Nobel Prize in Chemistry, corecipient
- Maks Samec, (1844–1889), Slovenian chemist.
- Carl Wilhelm Scheele, (1742–1786), Swedish 18th century chemist, discovered numerous elements
- Stuart L. Schreiber, (born 1956), American chemist, a pioneer in a field of chemical biology
- Richard R. Schrock, (born 1945), 2005 Nobel Prize in Chemistry
- Glenn T. Seaborg, (1912–1999), 1951 Nobel Prize in Chemistry
- Nils Gabriel Sefström, (1787–1845), chemist.
- Francesco Selmi, (1817–1881), Italian chemist
- Nikolay Nikolayevich Semyonov, (1896–1986), physicist and chemist, 1956 Nobel Prize in Chemistry
- Israel Shahak, (1933–2001)
- K. Barry Sharpless, (born 1941), 2001 Nobel Prize in Chemistry
- Patsy O. Sherman (born 1930), 12 US Patents
- Alexander Shulgin, (born 1925), Pioneer researcher in Psychopharmacology and Entheogens
- Peter Schultz, American chemist
- Oktay Sinanoglu, (born 1935), Turkish chemist
- S.P.L. Sørensen, (1868–1939), Danish chemist
- Frederick Soddy, (1877–1956), British chemist, 1921 Nobel Prize in Chemistry
- Wendell Meredith Stanley, (1904–1971), 1946 Nobel Prize in Chemistry
- Branko Stanovnik, (born 1938), chemist
- Hermann Staudinger, (1881–1965), polymer chemist, 1953 Nobel Prize in Chemistry
- Alfred Stock, (1876–1946)
- Fraser Stoddart, (born 1945), Scottish chemist, a pioneer in the field of the mechanical bond
- Theodor Svedberg, (1884–1971), 1926 Nobel Prize in Chemistry
- Gilbert Stork

T

- Richard Taylor, (1965-), Professor of Organic Chemistry, University of York.
- Henry Taube, (born 1915), 1983 Nobel Prize in Chemistry
- Miha Tisler, (born 1926), chemist.

U

- Harold Clayton Urey, (1893–1981), 1934 Nobel Prize in Chemistry.

V

- Lauri Vaska, (born 1925), Estonian/American chemist.
- Artturi Ilmari Virtanen, (1895–1973), chemist, Nobel Prize laureate
- Alessandro Volta, (1745–1827), electrochemist, Invented the Voltaic Cell

W

- Johannes Diderik van der Waals, (1837–1923)
- John E. Walker, (1941–), 1997 Nobel Prize in Chemistry
- Alfred Werner, (1866–1919), 1913 Nobel Prize in Chemistry
- George Whitesides, American chemist
- Heinrich Otto Wieland, (1877–1957) German chemist 1927 Nobel Prize in Chemistry
- Harvey W. Wiley, (1844–1930), US chemist, Pure food & drug advocate
- Sir Geoffrey Wilkinson, (1921–1996), 1973 Nobel Prize in Chemistry
- Friedrich Wöhler, (1800–1882), German chemist
- William Hyde Wollaston, (1766–1828), English chemist
- Robert B. Woodward (1917–1979), 1965 Nobel Prize in Chemistry
- Kurt Wüthrich, (born 1938), 2002 Nobel Prize in Chemistry
- Charles-Adolphe Wurtz, (1817–1884)

x

- Xiaoliang Sunney Xie, (born 1962), Chinese chemist at Harvard University. Famous for his pioneering work in Single Molecule Microscopy and CARS (Coherent Anti-Stokes Raman Spectroscopy) microscopy.

y

- Sabir Yunusov, (1909–1995), Soviet chemist (alkaloids)

z

- Ahmed H. Zewail (born 1946), Egyptian, 1999 Nobel Prize in Chemistry for his work on femtochemistry.



Safety First

1. If there is a possibility for eye damage, correctly-fitting safety goggles must be worn at all times.
2. Lab aprons are worn to protect you from any dangerous spills. However, even if you are not working with dangerous chemicals, substances such as fruit juices, often will stain and ruin your clothes if you spill them.
3. Make sure there is a fire extinguisher in the room. The extinguisher should be rated BC. Make sure you know how to use it.
4. Always make sure you have an adult nearby when working in a lab.
5. If you are working with any kind of flames, make sure you do not have any loose clothes, roll up your long sleeves, and tie long hair back.
6. Just because a container looks cool, do not assume that it is not hot. If you are not sure, don't touch it with your bare hands.
7. Never taste anything in a chemistry lab. If you need to taste something you should do it in a room where there are no other chemicals around.
8. Always add acids and bases to water. NEVER add water to an acid or a base.
9. Cleanup any spills immediately.
10. Let someone know if any glass breaks.
11. Wash your hands before leaving the lab or after you have finished doing an experiment.

Notes

Notes

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