#2600 How Soil Is Formed

This kit is designed to give students in natural science courses an understanding of the forces involved in soil formation. The students will simulate a series of physical, chemical, and organic processes that are involved in rock breakdown. The materials in this kit provide for the following experiments and demonstrations:

- A simulation of glacial activity using ice and sand
- A demonstration of the effects of expanding ice
- A demonstration of the effects of sudden temperature change
- The preparation of an artificial rock of sand and sodium bicarbonate to simulate the effects of acids (vinegar, in this case) on rock structure
- An example of the effect of plant growth within rock

The materials and experiments in the kit are suitable for junior and senior high school level students, as well as more advanced elementary school classes. The activities are designed for a class of 30 working in pairs, but can accommodate more students.

Contents:

Sand (0.90 kg)
Plaster of Paris (0.45 kg)
Sodium Bicarbonate (0.45 kg)
Dried Beans (.225 kg)
Gravel (0.45 kg)
Metal Cups (15 - 60 ml)
Magnifying Glasses (6)
Paper Cups (30 - 90 ml)
Styrofoam Blocks (6)
Pipettes (15)
Mixing Sticks (30)
Glass Vials (2)
Vinegar (240 ml)

Teacher Manual (1)
Student Instruction Master (1)

Addition Required Materials:

Bunsen Burner or Hot Plate Tongs Source of Tap Water
Samples of local rocks and soil
Paper Towel
15 ice cubes
Access to Freezer

HOW SOIL IS FORMED #2600 Teacher Manual

Introduction

All life depends on the thin top layer of soil covering the earth's surface. Topsoil provides support, water, and air to plants. In addition, topsoil provides the plants with a supply of nutrients, both inorganic and organic. The soil itself plays host to an incredible variety of animal, plant, and microbial life.

An impression of the importance of soil to the overall ecology is given by a few examples of soil misuse by man. The Great Dust Bowl of the 1930's, where hundreds of farms became unable to support plant life, resulted from over farming of the land. Areas where lumber had been harvested excessively in past years may now be barren wastelands. An understanding of soil ecology, and of the forces involved in soil formation and removal, is an important part of modern science.

This kit is designed to give students of any introductory courses in the natural sciences an understanding of the *forces* involved in soil formation. The students perform a variety of experiments which simulate the *chemical*, *physical*, and *organic* processes which combine to produce soil. Successful use of the kit requires little introductory work other than a brief discussion of organic and inorganic components of soil. The students may wish to examine samples of soils and rocks from the surrounding area. The activities in the kit may, depending on the amount of field work desired, involve extended amounts of time.

Teacher's Guide - Background Information

Soil is a mixture of weathered rock particles and decayed organic matter. The relative amounts and particle sizes of the components determine the physical characteristics of the soil.

The first step in this soil forming process is the weathering of rocks lying at or near the surface of the earth. Several of the processes involved are:

1) *Erosion* - Moving water, especially water carrying sand and silt particles, causes some breakdown of rocks. The water carries the particles along with great force, and acts like sand paper on the rocks below. Small particles of rock are broken off and are carried by the water, sometimes to be deposited far away from their original location. The Grand Canyon is the most well known example of the erosion of rock.

2) *Wind* - Wind is also an agent of rock breakdown, especially when it carries bits of grit and dust. These sandblast the rocks and cause formation of more rock fragments.

3) *Geological Changes* - The surface of the earth is in constant motion. As the separate pieces of crust move against and under each other, mountains, volcanoes, and huge rifts are formed. This is an extremely slow but powerful force in the formation of soil.

4) *Glacial Activity* - Glaciers played a significant role in the formation of most of the soil now present on the earth. During an Ice Age, glaciers move over hundreds of miles of rock. The pressure of thousands of feet of ice causes extensive breakdown of the rocks. The glaciers pickup the pieces of broken rock and carry them along. The transported rock acts, again, like sand paper on the rocks below. This causes further breakdown and formation of smaller and smaller particles.

5) *Temperature Effects* - Many rocks expand and contract with changes in temperature. Repeated expansion and contraction weakens the crystal structure of the rocks. This process accelerates as temperature changes become more

rapid. As the outer surface of the rock expands and contracts with changes in air temperature, the inner portions of the rock stay at a more constant temperature. The outer layers of the rock separate and crumble away from the inner layers.

6) *Water/Ice Changes* - Water is able to enter the rock through many cracks formed by thermal expansion and contraction. The water may react with some of the minerals in the rock, weakening the crystal structure. If the temperature of the water drops below the freezing point, the water turns into ice. As the ice expands, it pushes against the rock. Tremendous pressure builds up on the rock and causes further breakdown of the structure. Potholes form in this manner during early winter.

The processes mentioned to this point are physical ones. Once the rock has been broken down somewhat, chemical and organic processes begin to work. These processes include:

7) *Chemical Breakdown* - Carbon dioxide, sulfur dioxide, and various nitrogen compounds from the air form acids when dissolved in water. These acids may react with the rocks, particularly the carbonate rocks such as limestone, and increase the rate of breakdown of the crystal structures.

8) *Plant Activity* - Growing plant roots can exert tremendous pressure on surrounding rocks. Many city streets, sidewalks, and parking lots have been crumpled by the force of a growing tree.

9) *Organic Reactions* - In the process of normal metabolism, many by-products of plant, animal, and microbial activity such as carbon dioxide and other organic acids, are released to the environment. Many of these chemicals have the ability to break down rocks and rock fragments.

These activities produce a tremendous amount of rock fragments of various sizes. But this material is not true soil. Soil formation depends on the addition of organic materials to this mixture of rock fragments.

The first plants to gain a foothold on the decaying rock are usually mosses and lichens. These organisms contribute to the chemical breakdown already mentioned; in turn, their remains are broken down by bacteria and fungi. The resulting cell wall fragments and various other residual materials, such as lignins and pectins, adhere to the particles of rock. As more plants are established (first moss, then simple grasses or herbaceous plants, then shrubs, then trees) more organic material is added to the soil. Decomposers and animals such as insects and worms also contribute to the supply of organic material.

Soil formation is a continuous process. As water and wind remove soil from the surface, new soil is formed through the activity of the organisms near the surface and the weathering of underlying rocky material. In the long run, soil characteristics depend on the climatic conditions of the area. In excessively dry climates, for example, there is not enough water to sustain extensive chemical reactions. Soils in these areas tend to be formed primarily of large particles of rock, like the sandy soil of desert regions. In damper regions, water provides for increased chemical reactions and increases the extent to which organic materials will contribute to the formation of the soil. Such soils are often composed of extremely small rock fragments, and the upper horizons of the soil may be largely composed of organic matter, called *humus.*

The final property of the soil will be determined by the size of the rock particles and the proportion of organic material present in the soil. If the rock particles are coarse, the soil is sandy, and will not hold much water. Minerals will be rapidly leached out of this soil. A clay soil results from the presence of very small soil particles. Such soils do not allow much movement of air or water.

Teacher's Guide - Using the Kit in the Classroom

The kit is designed to be used by students in introductory earth or biological sciences as an introduction to the nature and formation of soil. No prior knowledge of geology is assumed.

This kit will introduce the student to:

a) a simulation of the processes involved in the breakdown of rock into soil. The student shall be able to relate each simulation to the processes occurring in nature, and to summarize the various forces involved in each experiment.

b) the importance of water in the breakdown of rock as both a physical and chemical force. Specifically the force of water through the formation of ice, the carrying of rock particles (by glaciers and running water), the dissolving or hydration of minerals, and the action of acids formed from dissolved organic or inorganic materials.

c) the difference between finely crushed rock particles and true soil. The student shall be able to discuss the importance of humus to organisms which depend on the soil.

d) the importance of plant life to soil formation. The student shall be able to list both the physical forces exerted by growing plants and the chemical reactions resulting from their by-products. The student shall be able to discuss the importance of plant material to the formation of humus material in the soil.

Preparing the Materials

Beside the materials provided, the following pieces of equipment should also be available: a Bunsen burner or hot plate, a pair of tongs, paper towels, 15 ice cubes, and a source of tap water. Access to a freezer (need not be in the school) and *samples of local rock and soil* are also needed. You may collect these yourself or have the students collect them. A large coffee can or a brown paper bag can be used for collecting samples. Label the samples with their original location. Try to have at least one sample of rich garden soil and a sample of local underlying rock formations.

You may want to spend some time examining and comparing various rocks and soil types. While the written materials included with this kit do not deal specifically with the types of rocks and soils, you may wish to discuss these topics in the course of performing the activities in the kit.

Two of the activities must be prepared in advance, one for the chemical forces demonstration, the other for the organic forces. The preparation of these has been placed after the Physical Processes section in the student guide. This conveniently divides the labs into two short lab periods, or into two class periods (45 min). You may wish to have the students prepare these materials prior to any lab work, and do the activities in one day.

Guide to the Student Materials

Encourage the student to look for evidence of organic materials, such as leaf fragments, small twigs, insect material, etc., when examining the samples. Point out mineral components in the soil such as crystals of material. Encourage the students to discuss how these types of material came to be part of the soil.

Discuss the differences between rocks and soil, leading to two basic areas: differences in particle size, and the presence of organic and other materials in the soil. Focus the students' attention on the two major phases of soil formation: the breakup of the rock material and the addition of the organic material. Demonstrations center around the various processes involved in the breakup of the rocks.

Physical Forces

Erosion is mentioned in the introduction to this section, but is not demonstrated in the lab activities. You should find pictures that demonstrate wind and water erosion. (The Grand Canyon and various rock structures in the Southwest are mentioned in the student manual)

1) *Geologic Activity*

Any two pieces of rock may be used to demonstrate abrasion. The students may also use pieces of chalk to simulate rocks. Point out, of course, that most rocks are not as soft as chalk!

2) *Glacier Activity*

The glacial activity simulation requires that each group of students have an ice cube, preferably one with a flat side. As the student moves it along the surface, the ice cube will pick up some of the pieces of sand. The transported sand will scratch the surface. In this way, glaciers during an Ice Age pick up rocks and scour miles of land over many thousands of years. If you live near a glacially-carved valley (characteristically U-shaped), point this example out to the students.

The next two activities are teacher or student demonstrations. You may choose a responsible student(s) to perform the demonstrations, because of the hazards of broken glass.

3) *Expansion of Ice*

To demonstrate the effects of ice formation, fill one of the small glass vials completely with water. Allow the vial to sit for a minute to allow all gas bubbles to escape. Seal the vial tightly and be sure that there is no air trapped inside the bottle. Wrap the vial in a paper towel and place it in a freezer overnight. *You may want to set this up a day before you have the students do the activities.* Show them the other empty vial for comparison; then unwrap the frozen vial. Ice takes up more room than the water. The ice formed in the vial will push against the walls, causing the vial to crack. A bottle already cracked by ice may be brought from home, but the demonstration is more effective if you can unwrap and display the vial with ice still inside it.

4) *Effects of Temperature*

This activity demonstrates the expansion and contraction effects of temperature change. Hold the empty uncracked glass vial (without the top) with a pair of tongs, and heat it slowly (to avoid premature cracking) over a Bunsen burner flame or on a hot plate. After a minute or so of heating, drop or dip the vial into a container of cold water. Use a large container, such as a pail, empty milk carton or large beaker, with a small amount of water. The glass will crack when it touches the cold water. Be careful with the glass fragments from the cracked bottle.

Chemical Processes

This activity involves the preparation of an artificial rock from sodium bicarbonate and sand. The preparation of this artificial rock is described on page 4, at the end of the Physical Processes section of the Student Instructions. As the mixture dries out (overnight), the bicarbonate crystallizes and looks very much like a sedimentary rock.

You may accelerate the drying process by heating the metal trays in an oven or on a hot plate. Use tongs to handle the hot metal trays and supervise the students closely to prevent accidental burns.

a) As water is added to the rock sample, it dissolves the bicarbonate crystals and the sample breaks apart. This demonstrates how water soluble minerals dissolve, and how rock is softened by hydration of certain ions. Point out that even a material which is not very soluble in water can be dissolved if large amounts of water run through or over it.

b) The vinegar reacts with the bicarbonate, producing carbon dioxide gas. This reaction breaks up the crystal structure of the bicarbonate and the rock crumbles. In the same way, various acids react with the carbonate rocks and other minerals in nature. Try adding an equal amount of acid, such as vinegar, or water to each of two equal-size samples of the bicarbonate "rock". The previously prepared rock samples can be used for this demonstration. After the reaction, reform the lumps of material and allow them to dry. The sample treated with water will be almost as strong as the original sample. The acid-treated sample, though, will be weakened, since the bicarbonate which bound the "rock" together has reacted with the acid.

Organic Processes

The germination of the bean seeds in the plaster provides a demonstration of the effect of growing plants on rocks. The small rocks in the other cup provide a control, showing that the addition of an inert object does not effect the strength of the plaster. The beans germinate in the plaster and the roots and stems will break up the structure of the hardening plaster. The rocks will become firmly imbedded in the plaster. If there is a tree in your area which has pushed up a sidewalk or a section of pavement, point this out as an example of this process.

Field Study - Formation of Humus

The formation of humus material cannot be easily simulated. Instead, the student will compare samples of surface soil and subsoil from the same area. Roads, buildings, or other land-moving projects provide excellent opportunities to gather the samples. These exposures of the soil also provide an opportunity to discuss the ongoing nature of soil formation. If a road cut or other exposed soil region is not available, you may obtain the samples by simply digging for them. Use the top few inches of soil for the topsoil sample, and a sample from about 2 feet below the surface for the subsoil sample. You may wish to have the students collect these samples.

As the students examine the two samples, point out the differences in the size of the soil particles. Because of chemical breakdown, erosion, etc., the mineral components of the surface sample will be much smaller. The topsoil will probably be a darker color due to the presence of organic material. The students should be able to see other evidence of the presence of organic materials in the surface soil as well.

As an optional experiment, you can demonstrate the presence of organic material in the soil by adding equal amounts (one teaspoonful) of soil and sub-soil, respectively, to each of two small glass jars. Add 25 ml of 3 M sodium hydroxide to each jar, seal, shake thoroughly, and let stand overnight. Compare the color of the liquid in the two jars and point out that the darker color of the surface soil sample indicates a large proportion of organic materials.

Topic for Further Discussion

After completing the initial set of activities in this kit, you may want to discuss some of the following topics:

1) Have the students investigate the chemical components in the soil, from the breakdown of both mineral and organic materials. The Science Source Kit #2000, Chemical Composition of the Soil, may be useful for this. You may also wish to obtain some of the excellent material available from the United States Department of Agriculture.

2) Investigate the various types of rocks and the types of soils that they become. Investigate the relationship between the type of rock, climate, vegetation, drainage, aeration, and the types of soils which are formed.

3) Investigate the decomposers found in the soil. These are primarily microorganisms such as bacteria and fungi, although insects and worms also break down organic debris. Investigate the types of microbes found in the soil using materials such as those in The Science Source Kit #2100, Soil Microorganisms. Have the students examine samples of wood, cloth, paper, etc. which have been left in soil for various periods of time, observing for signs of decomposition.

4) Investigate the drainage and aeration properties of different soil types. Measure such properties as water holding capacity, percolation rates, percentage of water found in a soil sample, etc. Discuss the interaction of particle size and amount of organic material present, and how this determines the characteristics of the soil.

5) Have the students investigate the macroscopic plant and animal life in the soil. Establish a soil terrarium in a closed container and have the students observe the environment over an extended period of time. Various seeds in the soil will germinate, as will spores of ferns, mosses, etc. Have the students collect and study animals from the soil, including many types of insects and other arthropods.

How Soil is Formed #2600 Student Instructions (annotated)

A great deal is said these days about the use and misuse of soil. Soil is what all of our food originally comes from. It is the very base for the entire ecosystem (the connected system of all living things) of the planet. All life on earth depends on the soil. Yet soil forms a layer only a few feet thick in most parts of the world. How is soil formed, and how is it different from rock?

This kit will help you to answer these questions. It will give you a background on how soil is formed through various physical, chemical, and biological processes.

A - General Observations

1) Observation of Soil Samples

You will need a paper cup, labeled with your partner's name and your own. Get a sample of soil in the paper cup and bring it to your lab station. Locate a hand lens and a mixing stick.

Examine the soil for a few minutes with the hand lens, using the mixing stick to separate the soil. Look for particles of different shapes, sizes, and colors. Look for evidence of any living materials which may be (or may have been) present in the soil. Summarize you observations:

(The soil will contain particles of different sizes, probably ranging from about 1 cm down to extremely small pieces. There may be some particles with a crystal structure and others with no regular shape. There may also be pieces of leaf fragments, animal fragments, fiber, and small twigs.)

2) Observation of Rock Samples

Let's look at some rock samples next. You probably found small rock fragments, or pieces of material which look like they came from rocks in the soil sample. Use the hand lens and the mixing stick to examine the rocks. The rocks should come from the same general area as the soil which you examined. Summarize your observations of the rocks:

(The rocks are solid and consist of very large fragments. As the rocks are moved around, small pieces break off Some of the rocks may appear to be made of various types of materials fused together, and others to be all one type of mate rial.)

How are the rocks different from the soil?

(The rocks are much more solid and uniform than the soil. The rocks consist of larger pieces than the soil does. The soil also contains organic material while the rocks do not.)

You probably know that soil is composed of broken-up rock fragments mixed with bits of plant and animal material. Let's see how rocks break down and become soil.

Part B - The Formation of Rock Fragments

Rocks may be broken down by three general processes: physical, chemical. and organic.

Physical Processes

Physical processes include large scale changes like geological changes and glacial activity. Other physical processes include water and wind erosion, ice expansion, and temperature effects. Erosion cannot be simulated easily in a lab, but examples of these two types of erosion are present everywhere. The Grand Canyon was formed by the erosion of rock by water. The water carries bits of grit and sand that wear down rock over long periods of time. The various rock structures in the plains of Utah and New Mexico are formed through wind erosion. The wind picks up small pieces of soil, and carries this grit along with it. Like water erosion, the grit in the wind will, over time, sand down and erode rock. Your teacher may have pictures of these examples.

1) Geological Changes

The Earth's surface is in constant motion. The rock that makes up the crust of the Earth is in huge plates that drift across the surface. At the edges of these plates the rock often grinds together, causing earthquakes and volcanoes. To simulate geologic changes on a very small scale, get two pieces of rock and hold them over a sheet of white paper. Rub the two rocks together. What happens to the rocks?

(The rocks will crumble into smaller grains and dust)

This same process happens on a somewhat larger scale any time rocks come in contact and rub against each other.

2) Glacial Activity

Thousands of years ago glaciers covered much of the earth. Glaciers are huge masses of ice and snow. Though they move very slowly, they are extremely heavy, and exert great force on the rocks underneath them. Most of the soil around today was formed by glacial activity thousands of years ago.

To simulate glacial activity, get an ice cube, a paper towel, some sand, and a styrofoam plate provided in the kit. Sprinkle a small amount of sand onto the styrofoam plate. Hold the ice cube with the paper towel, and slowly move the ice across the sand while pushing the ice down into the plate. This simulates the weight of the many feet of ice and snow in the glacier.

a) Lift up the ice cube after you have moved it a few inches, and describe the bottom surface of the ice cube:

(The sand picked up by the ice is now imbedded in it.)

b) Without rubbing the sand any more, carefully wipe off the surface of the plate, and describe the appearance of the plate where the sand was:

(The plate is scratched and gouged where the sand particles rubbed against it. Some of the small pieces of sand may have been forced into the plate.)

c) The rocks that the glaciers pick up rub against the stone they are carried over. Remembering what happens when rocks are ground against each other, predict what would happen as these rock bearing glaciers cross the land:

(The rock that the glaciers pick up act like chisels against the rocks underneath. The glacier would cause both sets of rock to become gouged and broken down. As larger rocks break down, they, in turn, are picked up and carried by the glacier, and will rub against more rock.)

3) <u>Ice Expansion</u>

Ice also has an effect on rocks even when it is not moving. Ice takes up more room than the same amount of water would (it is less dense). This is why ice cubes float in a glass of water. When water freezes, it expands. Water can easily seep into small cracks and crevices in a rock. When the temperature drops, the water freezes into ice, expanding while it does so. This creates great pressure against the rock, since the ice is trying to take up more room than was originally present.

Your teacher will demonstrate the force generated by freezing water, and its effect on, in this case, a glass vial. The vial represents the rock surrounding the freezing water in nature. You will be shown two containers, one that is empty, another which has been filled with water, sealed, and placed in a freezer.

a) Describe the appearance of the vial which was left in the freezer:

(The glass vial has cracked in several places.)

b) Explain what happened to the glass bottle:

(As the ice froze, it expanded. This pushed out against the glass, and caused the glass to break.)

This is the same manner in which potholes form in early and late winter, when the temperature changes a great deal. Rainwater seeps into small cracks in a road. As temperatures drop, the water freezes, and further cracks the road. If the temperatures rise enough for it to rain, the new rain water fills the larger cracks and again, will freeze, making the cracks even larger.

4) Expansion and Contraction Effects

Temperature changes have an effect even when there is no water present. As a rock gets warmer, it expands. Likewise, it contracts when it grows cold. The exposed surface of rocks is heated by the sun and air, while unexposed layers stay at a more constant temperature. These two layers will crack away from each other, since one is moving and the other is not.

The heated rocks on the surface are also quickly cooled by rain, cold winds, or night air. Your teacher will demonstrate the effects of rapid heating and cooling by heating the unbroken glass vial with a flame or a hot plate, and then dropping it into a container of cold water.

a) Describe what happens:

(The glass shatters when it hits the cold water.)

b) Judging from the effect of heating and cooling the glass bottle rapidly, what do you think would happen to rocks when they are heated and cooled?

(The rocks would probably crack and break up into smaller pieces.)

A couple of things must be setup for the next lab, and will need two or three days to sit. In preparation for the lab on Chemical Processes, you must make your own "rock" To do this, get a metal cup and label it with your name. Mix 2 to 3 spoonfuls of sand and the same amount of sodium bicarbonate (baking soda) together with a mixing stick. Add a few drops of water at a time to the mixture until you have a thick paste. Form the mixture into a mound, and put it aside until the next lab.

To prepare for the lab on Organic Processes, you will need two paper cups. Use the one that you had the soil sample in, and a fresh cup, labeling both with your name. Pour about one inch of plaster of paris into each cup. Add water, a small amount at a time, while mixing until the plaster forms a thin paste. When the consistency of the plaster in both cups is the same, add about 25 bean seeds to one cup, and the same amount of small rocks to the other cup. Cover the surface of the plaster with a piece of damp paper towel, and let the cups sit for a couple of days.

Chemical Processes

Chemical processes that break down rocks occur when gases such as carbon dioxide, sulfur dioxide, and various nitrogen compounds dissolve in water and form acids. These acids react with certain types of rocks, such as limestone, and weaken the rock structure.

1) General Observations

a) To study the chemical breakdown of rocks, you will use the "rocks" that you made in the previous lab. Using a hand lens, describe the "rock" that you have made.

(The material has hardened together. The particles of sand are imbedded in a white cement-like material.)

b) Did you see any rocks in the General Observation section which were similar in appearance to your artificial "rock"? If so, describe their appearance.

(Some rocks seem to be made up of different particles cemented together. Some of the particles probably looked like pieces of sand.)

c) Do you think that the sand by itself would have been as strong as this rock if you had not added the sodium bicarbonate?

(Wet sand does not hold together at all when it dries. The bicarbonate had a strengthening effect on the mixture.)

2) Chemical Reactions

a) Break your "rock" in two and leave one piece in the metal cup. Add a drop of water to the rock in the metal cup. Describe what happens to the material:

(The water dissolves the material, and the "rock" crumbles apart.)

Many components of rocks can be partially dissolved in water. When water reacts with these materials, it tends to soften the rocks. This is another aspect to the process of water erosion.

b) Add a drop or two of vinegar to the other half of your original sample. Describe what happens:

(The sample bubbles for a few seconds then stops. As the reaction occurs, the rock breaks apart and the sand settles in the dish.)

Air pollution gases and carbon dioxide formed by bacteria, plants, and animals dissolve in water to produce acids. These acids have an effect similar to the vinegar on certain types of rocks.

c) What do you think the continued effect of these acids would be?

(The acids formed would react with the minerals in the rock and the rock would tend to break apart into smaller pieces.)

SAFETY INSTRUCTIONS: IMPORTANT

Notice To Teachers Regarding Laboratory Reagents

Perhaps the best general rule regarding the safe handling of laboratory chemicals is to treat all of them as being potentially dangerous. This means that none of them should be taken internally, and that any external contact should be washed thoroughly. In fact, most of the chemicals provided in The Science Source kits are diluted enough that they are not hazardous. The following lists indicate appropriate antidotes for the hazardous chemicals. Check this list for the chemicals provided in the kit:

I. **Concentrated Acids & Bases** - **Do not** induce vomiting, dilute with water, then milk or egg white, call a physician immediately.

1. 25 % Acetic Acid
2. 3M Hydrochloric Acid
3. Concentrated Sulfuric Acid

II **Dilute Acids & Bases** - **Dilute** with water, then milk.

1. 1 M, 0.5M, 0.1 M Hydrochloric Acid
2. Oxalic Acid
3. Sodium Hydroxide
4. Ammonium Hydroxide

III **Miscellaneous Chemicals** - Dilute immediately with water. Induce vomiting with warm salt water, or warm baking soda solution.

1. Ammonium Chloride
2. Ammonium Oxalate
3. Barium Chloride
4. Biuret Reagent
5. Bromthymol Blue
6. Calcium Chloride
7. Ethanol (Denatured Alcohol)
8. Ferric Ammonium Sulfate
9. Hydrogen Peroxide
10. Janus Green B
11. Lead Nitrate
12. Lugol's Solution
13. Magnesium Reagent (Titan Yellow, Alcohol)
14. Mercuric Nitrate
15. Methylene Blue
16. Ninhydrin
17. Phosphorus Reagent (Ammonium Molybdate, Nitric Acid)
18. Potassium Ferricyanide
19. Potassium Permanganate
20. Silver Nitrate
21. Sodium Carbonate
22. Sodium Thiosulfate
23. Sudan IV

IV. **Organic Solvents** - **Do not** induce vomiting. Dilute with water and milk. Call a physician immediately.

Isopropyl Alcohol