ELECTRICITY for Family Living
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I. The Nature of Light

Light is a form of energy which travels at the fabulous speed of 186,000 miles (or 297,000 kilometers) per second. At this speed, you could travel completely around the world in the snap of your fingers!

Light, along with radio waves, heat and X-rays, are all forms of “electromagnetic radiation”. All travel at the same “super speed”. The only difference between them is “wavelength”.

We can visualize electromagnetic radiation as traveling in “waves” much like waves on the ocean. “Wavelength” is the distance between wave crests.

Notice that visible light is only a relatively small segment of the electromagnetic spectrum. The eye cannot detect, radiation with wavelengths longer or shorter than this narrow band.

Also notice that the color of light depends on wavelength. Within the visible light spectrum, the longest wavelengths are seen as red and the shortest are seen as violet. Light composed of all visible wavelengths (all colors) is seen as white.

We can see many things because they produce light themselves — such as the sun, an incandescent bulb, a candle, etc. Most things we see do not produce light, however. They are visible because they reflect light from another source.

If an object reflects some wavelengths but not others, it appears colored. For example, of the light that strikes a ripe apple, most of that reflected is of such a wavelength that the reflected light striking our eyes makes the apple appear red.

Measuring Light

How much light is enough? We know that sunlight on a clear day can be very bright — to the point of hurting our eyes. Other light, such as moonlight, is so dim that we have to make up for the dimness by holding the material closer to our eyes.

There is a way we can measure how much light is present. The total amount of light that a light source produces - measured at the surface of the source - is expressed in lumens. The number of lumens produced by a general-purpose incandescent bulb increases with the wattage of the bulb, as follows:

<table>
<thead>
<tr>
<th>WATTS</th>
<th>LUMENS</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>235</td>
</tr>
<tr>
<td>40</td>
<td>455</td>
</tr>
<tr>
<td>60</td>
<td>870</td>
</tr>
<tr>
<td>100</td>
<td>1750</td>
</tr>
<tr>
<td>150</td>
<td>2880</td>
</tr>
<tr>
<td>200</td>
<td>4010</td>
</tr>
</tbody>
</table>
Generally, an incandescent bulb with a lower lumen output will have a longer life of service, but with less efficiency.

Since a fluorescent tube is more efficient than an incandescent bulb it can produce several times as many lumens and will burn much longer, too. A 40 watt fluorescent bulb will produce 3150 lumens and last 20,000 hours. You can see how using fluorescent tubes in place of incandescent bulbs is an important way to conserve energy.

The amount of light that falls on a surface from a light source is measured in footcandles. For the sake of definition, we can say that a footcandle is the amount of light that falls on a surface one foot square when held one foot away from a standard candle. Footcandles are related to lumens in that, if one lumen falls on one square foot, we have one footcandle of illumination.

The amount of light that falls on a surface decreases sharply as the surface moves away from the source. This is because the light rays fan out as they travel, leaving fewer rays to fall on each given area of surface.

If we want to know the number of footcandles falling on a surface, we can use a “light meter”. Simply set the instrument at the point where the illumination is to be measured and read the footcandles directly on the scale.

4. The strength of the eyes of the user. For instance, an older person generally needs more light than a younger person.

Lighting experts have arrived at guidelines on how much illumination is needed for various tasks. How does your home rate in areas where these activities are carried on?

**Illumination In**

<table>
<thead>
<tr>
<th>Footcandles</th>
<th>Visual Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-20</td>
<td>Card playing, halls and stairway areas, room “background” lighting</td>
</tr>
<tr>
<td>20-30</td>
<td>Casual reading, easy sewing (such as basting with contrasting thread)</td>
</tr>
<tr>
<td>30-50</td>
<td>Household activities in kitchen and laundry</td>
</tr>
<tr>
<td>40-70</td>
<td>Prolonged reading or study: sewing on medium-colored fabric or machine stitching; shaving, facial make-up; work at a workbench</td>
</tr>
<tr>
<td>100-200</td>
<td>Fine sewing: hobbies with small details</td>
</tr>
</tbody>
</table>

Now we know how we measure the amount of light put out by a source and the amount of light that falls on a surface. But light is also reflected from surfaces.

Different surfaces will reflect different amounts of light than others. The ability of a surface to reflect light is called its “reflectance”. If a surface reflects all the light that falls on it, it has 100% reflectance; if it reflects none (that is, absorbs all the light) it has zero reflectance. Of course in the real world, nothing has zero or 100% reflectance — some light is always reflected and some absorbed.

As you can probably imagine, various surface colors reflect light to various degrees. The table below shows the approximate reflectance of various colors on painted surfaces:

<table>
<thead>
<tr>
<th>COLOR</th>
<th>% REFLECTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>80 to 85%</td>
</tr>
<tr>
<td>Pale pink or yellow</td>
<td>75 to 80%</td>
</tr>
<tr>
<td>Ivory</td>
<td>70 to 80%</td>
</tr>
<tr>
<td>Cream</td>
<td>65 to 75%</td>
</tr>
<tr>
<td>Buff</td>
<td>55 to 65%</td>
</tr>
<tr>
<td>Gray</td>
<td>35 to 50%</td>
</tr>
<tr>
<td>Light Blue</td>
<td>35 to 50%</td>
</tr>
<tr>
<td>Light Green</td>
<td>30 to 40%</td>
</tr>
<tr>
<td>Dark Green</td>
<td>15 to 25%</td>
</tr>
<tr>
<td>Red</td>
<td>15 to 25%</td>
</tr>
<tr>
<td>Dark Blue</td>
<td>5 to 15%</td>
</tr>
<tr>
<td>Brown</td>
<td>8 to 12%</td>
</tr>
<tr>
<td>Black</td>
<td>2 to 5%</td>
</tr>
</tbody>
</table>

As we observed earlier, there can be too much light or not enough light to do various tasks.

The quantity of light needed depends on:

1. **The size of the object.** If the print in a book is small, more light is needed to read it.
2. **The amount of “contrast” between the object and its background.** If black letters are printed on white, less light is needed than if the letters are gray.
3. **The time allowed for the eyes to focus on an object.** If an object must be seen quickly, more light is still needed. Dusk, therefore, is a hazardous time for driving, because our eyes cannot focus quickly on other objects.
In a home, it is recommended that ceilings have a high degree of reflectance, walls a high to medium degree and floors a lower degree, but not less than 15%. A high degree of total reflectance in the home means that with a brighter room, less electricity is needed for lighting and more energy is conserved.

Quality of Light

When electricity was first introduced into homes early in the 20th century, many rooms were lighted simply with a bare bulb suspended from the ceiling by its wire. The improvement over candles or lanterns was so great that no one even considered the “quality” of the light. Simply having it was important enough!

More recently, we have come to realize that the manner in which light is used — as well as the amount of it — has much to do with our ability to see our work efficiently and even our disposition. Unfortunately, even today not enough care is devoted to designing lighting with the best possible quality.

What are some of the things we should consider in looking for good quality lighting?

Glare: One of the most obvious problems in “bad lighting” is glare. Glare is concentrated light rays hitting your eyes in such a way as to make seeing harder and to put a strain on your eyes.

You can demonstrate glare by the following experiment: Cut a hole two inches in diameter in the center of a large piece of white cardboard. Print letters an inch high closely around the hole using a black crayon. Hold a 100-watt light bulb in the hole from the side of the cardboard opposite the lettering. Have a friend stand about 5 feet away and turn on the light. Can your friend read the lettering?

We can reduce glare by “diffusing” or scattering the light. Light can be diffused by using:

1. a frosted incandescent bulb
2. fluorescent lights
3. indirect lighting — that is, shielding the light source so that much of the light reaches the eyes through reflection from another surface. Shielding can produce 5 types of lighting:

   a. Indirect Lighting 90 to 100% of the light is directed upward, 0 to 10% downward. Little glare, with shadows practically eliminated.

   b. Semi-indirect Lighting 60 to 90% of the light goes upward and 40 to 10% downward. Causes a bit more glare and shadow than indirect.

This is an example of direct glare. Other sources of glare are bare light bulbs, lamp shades that do not screen light well and poorly designed light fixtures. Glare can also result from reflected light. Book pages, desk tops and shiny paint, can all cause glare if they do not properly scatter the light striking them.
c. **General Diffuse Lighting** 40 to 60% of the light goes upward, 60 to 40% downward. Throws light in all directions.

![Diagram of General Diffuse Lighting]

4. A diffusing screen or “diffuser” placed around the light source. A diffuser is usually made of “translucent” (allowing light to pass through, but scattering it as it does so) material such as plastic or glass. There should be at least \( \frac{1}{2} \)-inch to \( \frac{3}{4} \)-inch clearance between bulb and diffuser to avoid “hot spots”. You have likely seen these types of diffusers around the home:

![Diagram showing various types of diffusers]

d. **Semi-Direct Lighting** 10 to 40% of the light goes upward, 90 to 60% downward. Most of the light is directly on the work surface, with some glare and shadows as a result.

![Diagram of Semi-Direct Lighting]

e. **Direct Lighting** 0 to 10% of the light goes upward, 100 to 90% downward. Maximum light is on the working surface, causing excessive contrast between light and shadow. This lighting causes the most glare.

5. A good lamp shade. A good shade should have a wide opening at the top (at least 8\( \frac{1}{2} \) inches), with a minimum diameter of 15 inches (table lamps) or 18 inches (floor lamps) at the bottom.
Direction Be sure the light comes from the proper direction when you are studying, writing or using your hands for other jobs. If you are right-handed, most of the light should come from the left. If you are left-handed, most of the light should come from the right. This is so that your hand won’t throw a shadow across your work. Place lamps in the room so the light is well directed from one side or the other. If light falls directly in front of you, it may cause glare and when it falls directly behind you, your shadow may fall on your work!

Things To Do

1. Light Measurement
   Obtain a light meter and check the light levels (in footcandles) falling on various important work surfaces around your home. Examples are: desks, kitchen counters, tables, laundry counter, workbench and sewing table. Record the light levels on a chart, discuss with the club whether the light levels measure up to standards.

2. Experiment with Reflectance
   Find several samples of wallpaper, each about two feet square, in as wide a range of colors (from light to dark) as possible. Mount one of the paper samples on a wall using masking tape. Select a wall with as much light falling on it as possible (natural sunlight plus room lighting).

   Take incident and reflected light meter readings by aiming your meter first at the light source, then at the color sample. Compute the reflectance. Record the readings, the paper color and the reflectance in the following table:

<table>
<thead>
<tr>
<th>COLOR</th>
<th>INCIDENT LIGHT</th>
<th>REFLECTED LIGHT</th>
<th>% REFLECTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   Repeat, using different colors. Place the pieces in the same place and take measurements only when light conditions are the same.
   Which color reflects more light?

3. Demonstrate “glare”, “contrast” and “direction” in poor lighting situations and describe how to correct them.

Contrast Sharp differences in light and dark cause “contrast”. Too much contrast may cause eye strain because the eyes must adjust constantly from light to dark. The figure below shows an example of too much contrast.

Using only one light source in one part of a room causes contrast because some areas of the room are dark and others are bright. Reading a book on a dark desk with only one light in the room is tiring to the eyes because of the contrast between the book and its surroundings.

Watching TV without any lights on in the room is equally tiring.

Like glare, contrast can be reduced by diffusing the light source, especially by using indirect lighting. The area is more evenly illuminated this way. Using additional light sources also helps.
II. Types of Light Sources and Fixtures

In an earlier unit of the Electric Energy program we learned about how electricity produces light.

In the case of the incandescent bulb, we learned that a fine piece of wire, called the "filament," which has very high resistance to the passage of electricity, is made to heat up to the point of glowing with white-hot radiance. In such bulbs some 90% of the energy released is in the form of heat — only 10% is in the form of light. The construction of a typical bulb is shown below:

![Incandescent Bulb Diagram]

In the case of fluorescent tubes we saw how electrons released from a heated filament strike mercury atoms, causing them to release ultraviolet rays which in turn strike phosphor crystals coating the inside of the tube, producing visible light.

![Fluorescent Tube Diagram]

Fluorescent tubes cannot be connected directly to 120-volt circuits. Unless they are rapid start or instant start tubes, they must use a "ballast" to get them going. The ballast, a type of transformer, does two major things:
1. It supplies the correct operating voltage to the lamp.
2. It limits the amount of current provided to the lamp. (Without the ballast the lamp would draw more and more current until it destroyed itself.)

Fluorescent tubes must use some method of starting the arc (stream of electrons) flowing in them. Earlier lamps required a separate starter, but newer ones have the starting mechanism built into the tube and ballast. The starter is basically a switch that provides a complete circuit for current to flow through the filaments in the end of the tube. This causes the filaments to heat up. The starter then automatically opens to remove the filaments from the circuit when they have become hot enough to start the electrons flowing in the tube.

![Start Switch Diagram]

Let's now take a look at the many different shapes and sizes in which these two basic types of light sources are found and their uses.

**Incandescent Lamps** come in many shapes and sizes with different letter designations, as the diagram below shows. Type "A" is the most common.

![Incandescent Lamps Diagram]

Many special lamps are available in many of the above shapes and sizes, but with special features for special tasks:
1. *Frosted Bulbs* These bulbs are "frosted" or have a special chemical coating on the inside which diffuses the light emitted by the filament. Frosted bulbs should be used wherever glare could be a problem.
2. *Silvered Bulbs* Some bulbs have silvered bowls to reflect light upward or silvered sides to reflect light downward. Cone-shaped bulbs with silvered sides are used as floodlights or spotlights.
3. **Rough-service Bulbs** These have heavier filaments so they can withstand vibration and shocks. Some have a plastic outer coating to keep them from shattering.

4. **Colored Bulbs** Bulbs which give off colored light will have a colored bulb. The glass itself may be colored by adding chemicals when the glass is made, or the bulb may be coated with a colored enamel on the inside or outside. "Bug-away" bulbs are yellow-orange in color and are used where attracting insects is undesirable, such as around doors to home. Bugs are not attracted to light whose wavelength is yellow or red because they cannot see it.

5. **Infrared Bulbs** Some incandescent bulbs are designed to give off a high amount of light in the "infrared" region of the electromagnetic spectrum. Such bulbs are usually called "heat lamps" and are used to keep small animals warm (as in a chick brooder), to keep food warm prior to serving and to give "heat treatments" to sore, stiff muscles. Incandescent bulbs also come with a variety of bases, as shown in the figure below. Medium bases are used most often for general lighting. Large bulbs will use the "mogul" base and decorative lamps may use intermediate or candelabra bases.

**Fluorescent Tubes** also come in a number of shapes and sizes just as do incandescent bulbs.

Most fluorescent tubes are straight, but may also be bent into a "U" or a circle. The tubes come in different lengths and diameters. Several different bases are used with fluorescent tubes. Also, fluorescent tubes are available to fit into a regular incandescent bulb socket.

Fluorescent tubes are specifically built for the ballast they are to be used with. When replacing fluorescent bulbs (which you should do when you see one flickering or, of course, when one is burned out), the replacement should always be matched to the ballast. One type of lamp should not be replaced with another type.
Fluorescent lamps also come in different colors — not in the sense of yellow, red or green colors, but different tones of white light. The color of a tube depends upon the kind of phosphor which is used to coat the inside.

Lamps, which produce ultraviolet radiation, are also available. The light from these can be used to produce the common "black light" effect, to tan skin or to kill germs.

Some of the different types of fluorescent tubes according to color are:

<table>
<thead>
<tr>
<th>Name of Tube</th>
<th>Color Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Cool White</td>
<td>Gives a bluish-white light. Very efficient. Used for color matching or for laundry to show up spots and stains. Gives an unpleasant bluish cast to food and skin.</td>
</tr>
<tr>
<td>White</td>
<td>Not as blue as the above; a good general-purpose light for kitchens, workrooms, shop areas.</td>
</tr>
<tr>
<td>Deluxe warm light</td>
<td>Most nearly like incandescent lighting in color, preferred for pleasant appearance of food and skin. Not quite as efficient as above types. Preferred for most living and eating areas.</td>
</tr>
<tr>
<td>Deluxe cool white, deluxe soft white</td>
<td>The deluxe versions give slightly less light per watt than the standard types, but the light gives people and food a more pleasant appearance. Preferred for office areas.</td>
</tr>
</tbody>
</table>

If we add a simple diffuser, of the types discussed earlier, our ceiling fixture becomes useful in other rooms. A common type uses a simple globe diffuser and is used for general lighting in kitchens, bedrooms, hallways, etc.

Of course, ceiling fixtures can be very elaborate, such as the fine chandeliers we sometimes see in home dining rooms, hotel or business lobbies, etc.

Lighting Fixtures

There are many different types of fixtures which can be used to house light sources — either incandescent or fluorescent.

Incandescent ceiling fixtures One common incandescent fixture is the simple ceiling-mounted socket which can be controlled by a pull-chain or wall switch. This type of fixture can be used where bare bulbs are not objectionable, as in closets, garages and workshops.
"Bullet" type ceiling fixtures (which can also be used on walls) are used where concentrated light is needed for a task or for decorative lighting.

Some ceiling fixtures are simply cylinders designed to direct the light downward in a narrow concentration. These are often used for decorative effect in hallways, along one wall of a room, etc.

Fluorescent ceiling fixtures come in many styles. Exposed tubes are used in many places where light direction is not critical.

Louveres or lenses can be added where light must be directed for good light quality, such as in offices or classrooms. Decorative touches can be added when the fixture is to be used in homes.

Some ceiling fixtures are “recessed”, or partially hidden in the ceiling. Some will distribute light over a wide area, while others concentrate it in a small beam. Sometimes these are called “top hat” fixtures because the metal housing resembles a gentleman’s formal headgear!

Some recessed fixtures contain a rotating ball-shaped element that may be turned to project light in any direction below the ceiling line. These are called “eyeball” fixtures. Some include a reflector to guide the light “sideways” toward a nearby vertical plane and are called “wall-washers”.

Fluorescent Reflecting Equipment
Another form of recessed light is the “luminous ceiling”. In this case, fluorescent lamps are fixed on the ceiling and a false ceiling of louvers or translucent panels is suspended below. This lighting is suitable for kitchens, bath and laundries. Dimming controls should be included with luminous ceilings.

Wall-Mounted Fixtures Several wall-mounted fixtures are shown below. The linear type may be used in either horizontal or vertical positions. These may use either a series of incandescent bulbs or fluorescent tubes, and are typically found in bathrooms or above beds. The exposed-lamp type is usually for decorative purposes. The cylinder lamp holder is often used for lighting walkways or building entrances.

Still another form of ceiling fixtures are “pendant” fixtures, which are suspended by wire or decorative chain to get closer to their use. Many chandeliers and work lights are of this type. Pendant fixtures may be used as decorative lighting in many instances.

Structural Lighting Structural lighting must be planned and “built-in” when a room is built or remodeled. These installations provide special indirect lighting effects or supplement room lighting. Cornice lighting can be used to accent wall coverings and draperies. Valance lighting is usually used over windows, providing upward light to add to the general room lighting as well as downward light to accent the draperies. Cove lighting can be used to add to general lighting in rooms with near-white ceilings.
**Portable Lamps** Portable lamps, often called table lamps, are used for their decorative appeal as well as for their light. They must be designed and purchased carefully to provide a good light source as well as to be attractive. They can be made to use on a desk or table, or to set on the floor.

Lamps can be considered as having five main parts: a bulb, a socket, a shade, a diffuser and a base.

Shades may be “translucent” or “opaque”. Translucent shades let the light shine through, but cannot be seen through. Opaque shades will not let any light shine through at all. The inside of lamp shades should always be white and never shiny. The material of the lamp shade should be suited to the use of the lamp, such as moderately transparent to opaque (white vinyl, parchment or white-lined fabric) for study or reading lamps or highly translucent (thin plastic, fiberglass or silk) for make-up lamps.

Lamps should use diffusers to spread the light evenly — especially when they are to be used for studying.

**Things To Do**

1. Show different types of incandescent and fluorescent bulbs and tell how they are used.

2. Compare clear, inside frosted and white bulbs and how each affects glare. Show the use of shades or indirect lighting to reduce glare.

3. **Conduct a Home Lighting Survey**

   Make an information chart of the structural lighting in your home. Name the locations, type, use, wattage and whether the light quality is good or poor for the purpose intended. Did you do anything to improve the lighting along the way? Keep a record of the improvements you made or suggested.

<table>
<thead>
<tr>
<th>ROOM</th>
<th>LIGHT LOCATION</th>
<th>TYPE</th>
<th>WATTAGE</th>
<th>USE</th>
<th>QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR</td>
<td>end tbl. lamp</td>
<td>Inc.</td>
<td>150</td>
<td>Gen Purp.</td>
<td>good</td>
</tr>
<tr>
<td>Kitchen</td>
<td>ceiling</td>
<td>Fluor.</td>
<td>60</td>
<td>Gen. Purp.</td>
<td>good</td>
</tr>
</tbody>
</table>

You may wish to sketch the “floor plan” or layout of your home showing where light fixtures or lamps are located.

4. **Take a Lighting Field Trip**

Visit a lighting equipment dealer or the lighting department of a good department store. Notice all of the many different kinds of fixtures, lamps and bulbs. Look for the wide variety of bulbs offered, and how they are different in appearance and output.
III Lighting with a Purpose

Three kinds of lighting are generally required for an all-around well-planned lighting system for the home: general lighting, task lighting and decorative lighting. We've looked at some of the various types of light sources and fixtures available for home use. Now let's see how we can use these different sources and fixtures for different lighting needs.

**General Lighting** Some of the purposes of general lighting are:
1. In living areas, to reduce the contrast in brightness between task lighting and other areas of the room.
2. In utility areas, to light work surfaces and create a pleasant working environment.
3. In bedrooms, for dressing, housekeeping chores, care of children and invalids and ease of seeing into drawers and shallow closets.
4. In entrance halls for a cheerful welcome and in passageways and stairways for visibility.

General lighting requires light levels less intense than those needed for special purposes such as reading, sewing and other tasks.

You can use table lamps, floor lamps and pole lamps as well as permanent fixtures to provide general lighting. Light-colored walls and ceilings will reflect more light and add to the general lighting level in the room. With dark-colored walls, the room will need more light sources to achieve the same general lighting level, and more energy will be required.

**Task Lighting** Providing lighting for specific tasks means selecting the correct light source and making sure it is properly placed. Let's look at some well-planned lighting for some common tasks around the home.

1. **Light for Study** We know that good lighting is very important for study as it can affect our concentration. We should start with a desk that has a light-colored, non-glossy top. If yours has a dark or glossy top, add a light-colored blotter. The desk should be placed away from family activities and conversation, and not in front of a window. The wall behind the desk should be painted a light color and be non-glossy. The wall covering should be plain or simply patterned.

The light itself for your study center may come from one of several sources. You can use a desk lamp, floor lamp, a pendant lamp or a pair of small wall lamps. If you use a single lamp, it should be placed close to the task and in such a position that the light comes from the side opposite your work hand. You should use a light bulb or bulbs totaling at least 150 watts in a single study lamp.

The diagram below shows the proper dimensions for a study lamp, as well as for its proper placement on your desk.

If you use a pair of small wall lamps, they should have diffusers and at least 100-watt light bulbs. Their shades should be at least 9 inches across the bottom.
Fluorescent-lighted shelves also work well for study. They should have an opening at the top so heat and some of the light can be directed upward. A frosted glass diffuser under the light will help reduce glare and will spread the light over the entire desk surface. One or two 30- or 40-watt fluorescent tubes should be ample. The diagram below illustrates the best position for a shelf light.

High intensity lamps, bullet lamps with opaque shades, or small narrow-shaded lamps do not provide good lighting for study.

Sometimes you may want to do some casual reading in bed. The requirements are the same, and the same types of lamps can be used. The lamp should be placed so that the bottom of the shade is about 20 inches above the surface of the bed. A fluorescent wall bracket also provides excellent lighting for reading in bed.

You may want to make your own study lamp. The Things To Do at the end of this section will show you how.

2. **Light for Casual Reading** Lighting that is adequate for study is fine for casual reading also. However, lighting for this purpose does not have to meet the same requirements as for study. This is because we usually do not read for prolonged periods and may take frequent breaks.

   Lamps for casual reading should have light bulbs totaling at least 150 watts.

   Table or floor lamps can be used for casual reading. As a general rule, the bottom of the shade should be even with eye level when the lamp is beside you — about 6" higher when placed behind you.

3. **Light for Good Grooming** As with all special tasks, good lighting helps us in grooming, too. If you do your grooming at a desk or dresser in your bedroom, you should use two lamps placed on either side of your mirror. Their placement will depend on whether you are normally seated or standing, as the sketches below indicate.

   The lamps should have translucent shades that are white or off-white so your complexion color will not be distorted. A 100-watt frosted white bulb is fine, although 30-70-100-watt three-way bulbs will allow the lighting levels to be varied.
Fluorescent or incandescent lighting can be used. If you do your grooming at the bathroom basin, light can be evenly provided with three fixtures: one at each side of the mirror placed so the lights are at cheek height (usually about 60 inches from the floor) and about 30 inches apart, and a ceiling fixture directly above the mirror. 12 to 18 inches away from the wall. The third fixture can be an ordinary ceiling fixture, at least 12 inches in diameter, using two 60-watt bulbs. The wall lights should use two 60 or 40-watt bulbs each.

For fluorescent lighting, use deluxe warm white lamps. Two 20-watt tubes will be required in the ceiling fixture and one 20-watt tube in each side fixture. A single fluorescent fixture in the ceiling is best for use with mirrors that are wider than 36 inches.

4. Light for Sewing Sewing is a task that may be done in several different rooms in your house, as well as in various areas in a particular room. All sewing requires a considerable amount of light, whether sewing by machine or by hand. You may not sew, but someone in the family who does will appreciate your help and knowledge in making their sewing tasks easier.

Light for occasional hand sewing can be provided by a table or a floor lamp as shown.

Prolonged sewing, sewing on dark materials, or fine embroidery and needlepoint all require 200 footcandles of illumination. This can be provided by:

a. Using a high intensity lamp in combination with a floor or table lamp.

b. Clamping an adjustable holder with a 75-watt R-30 spotlight to the floor lamp or table lamp. The lamp should be position below eye level.

c. Using a pole lamp with an adjustable bullet housing and a 75-watt R-30 spotlight.

Lighting for machine sewing can be provided by a wall lamp without a diffuser, or a pole lamp using 75-watt R-30 floodlights. Position the lamps as shown in the diagrams.
If you plan to develop a sewing center, think of the different phases in sewing a garment: laying out the fabric and pattern, cutting, marking, basting, machine stitching, hand sewing and pressing. Plan the arrangement of equipment and furniture before deciding on any light fixtures.

**Decorative Lighting**

Light can be used to highlight a treasured work of art or to create patterns of light and shadow that accentuate the texture and layout of such items as draperies, fireplaces, and paneling.

Decorative lighting often contributes to the level of general background lighting in a room; but by its very nature it is usually unsuited to task lighting.

Permanent decorative lighting — such as “eyeball,” “wall-washer,” or “high hat” fixtures — or built-in schemes such as cornice, valance and cove lighting (all of which we have discussed earlier) do not include the fixture itself as part of the decor. In fact, the fixture is usually hidden.

There are, of course, a number of fixtures that are themselves decorative.

Pole lamps with adjustable “bullet” fixtures can be used to accent a picture, wall-hanging or planter. Decorator chain lamps make it possible to hang lamps anywhere from the ceiling. The wire is usually camouflaged by weaving it in and out of the decorative chain that is used to hang the lamp. The chain and wire can then be dropped down along a wall to be plugged into a convenience outlet.

2. Show how a chair and floor lamp should be placed for hand sewing. Indicate how to use a clamp-on lamp holder for additional lighting.
3. Demonstrate proper light levels and lamp positions for reading or study.
4. **Conduct a Lighting Improvement Campaign at Home**
   Check all the lights in your home and make sure the following things are done.
   a. Clean all bulbs, shades and lamps by wiping with a damp cloth (be sure bulbs are off and cooled first!). Your lighting equipment should be cleaned in this way once a month.
   b. Check lamp shades for white linings or material that transmits light.
   c. Be sure that cellophane wrapping is removed from all lamp shades.
   d. Check to see if there are any darkened bulbs in your lamps or lighting fixtures. If so, move these darkened bulbs to a hallway, closet, basement, garage or porch, or discard them.
   e. For energy efficiency, use bulbs of lesser wattage for hallways, TV viewing, and dining.
   f. Remove glare by replacing bare bulbs overhead by decorator or silver-tip bulbs, or by purchasing a clip-on shade to use on the bare bulb. Replace bare bulbs in lamps with frosted or white bulbs.

Keep a chart on your activities to make sure you have checked every lamp and fixture.

5. **“Score” Your Study Lamp for Good Lighting**
   How does your study lamp “measure up”? Use the diagram below to compare its dimensions to your lamp.

![Diagram of study lamp dimensions]

<table>
<thead>
<tr>
<th>Your Lamp</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>9&quot;</td>
</tr>
<tr>
<td>b</td>
<td>16&quot;</td>
</tr>
<tr>
<td>c</td>
<td>15&quot;</td>
</tr>
<tr>
<td>d</td>
<td>10&quot;</td>
</tr>
<tr>
<td>e</td>
<td>25&quot;</td>
</tr>
</tbody>
</table>
Now check the following:

a. What size bulb (or bulbs) does it have (in watts)?
b. What is the voltage marked on the bulb?
c. Does the lamp have a reflector bowl?
d. Does some light go out the top?
e. Do you see the bulb directly when you sit or stand at your desk?
f. Is the inside of the shade light or dark?
g. Is the shade clean?
h. Is the bulb darkened?
i. Is the cord in good repair?
j. Is the switch in good repair?

Now check the position of the lamp. Without moving it, see how far it was placed from the correct position. There should be 15 inches from the center of your working area to the center of the lamp base and 12 inches from the front of the desk. The bottom of the shade should be at eye level. Right-handed people should place the lamp to their left; left-handed people to their right.

Finally, use the following point chart to “grade” your lamp. Award it any number of points in each category from zero for “no good” to the maximum number allowed for “perfect.”

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness (150-watt bulb)</td>
<td>25</td>
</tr>
<tr>
<td>Absence of harsh shadow when hand is held</td>
<td>10</td>
</tr>
<tr>
<td>spread out between lamp and work</td>
<td></td>
</tr>
<tr>
<td>Even light distribution both down and up</td>
<td>10</td>
</tr>
<tr>
<td>Wide distribution of light</td>
<td>10</td>
</tr>
<tr>
<td>Shade wide enough at bottom and top</td>
<td>4</td>
</tr>
<tr>
<td>Shade deep enough to hide bulbs</td>
<td>2</td>
</tr>
<tr>
<td>Shade white-lined</td>
<td>3</td>
</tr>
<tr>
<td>Shade made of dense, opaque material</td>
<td>3</td>
</tr>
<tr>
<td>Bottom of shade 15&quot; from desk top</td>
<td>3</td>
</tr>
<tr>
<td>Lamp properly placed in relation to work</td>
<td>20</td>
</tr>
<tr>
<td>Right size lamp for room decor</td>
<td>5</td>
</tr>
<tr>
<td>How materials used in base and shade appear</td>
<td>5</td>
</tr>
<tr>
<td>How does your lamp score? If it scores low, take whatever measures that are needed to improve its rating.</td>
<td></td>
</tr>
</tbody>
</table>

6. Build a Study Lamp.

With just a few materials and tools you can build a lamp with a diffusing bowl that directs some light upward and some light gently downward, all with a minimum of glare and shadow.

Materials Needed:

two pieces of wood 1" x 2" x 13" for stem
one piece of wood 7½" x 7½" x ¾" for upper half of base
one piece of wood 8" x 8" x ¾" for lower half of base

Lamp socket threaded for ¼" pipe with 3-position switch for 3-way light bulb
14½" length of ½" pipe threaded at both ends
lock washer and nut to fit threaded pipe
Shade holder to fit socket and support the diffusing bowl (not needed if bowl is thread plastic)
White-lined shade with 16" bottom diameter
9½" diffusing bowl
3-way light bulb (50-100-150 watt)
9-foot lamp cord with plug. Not smaller than No. 18
AWG UL approved conductor.
Six 1¼" No. 10 flat-head wood screws
Wood glue, fine sandpaper, carpenter’s tools.

Steps To Take:

a. Prepare the base. Drill a ½" diameter hole in the center of the upper half of base. (This is the 7½" x 7½" x ¾" piece.)
b. Drill a 1¼" diameter hole in the lower half of the base. (This is the 8" x 8" x ¾" piece.)
c. In this same piece, drill a ¼" hole from an edge to the center hole.
d. If you wish, round the upper edges of both pieces with a wood rasp and sand to a smooth finish. This gives you a base with a slightly different style.

Make the Stem
Either of These Two Ways

- 2 pieces 1" x 3" x 13"
- 4 pieces 1" x 1" x 13"

Make the stem:

a. Cut a “V” groove the length of each stem piece. Make sure the grooves match (see illustration). Make grooves 7/16" wide and 1/4" deep.

(Note: another way to make the stem is to take 4 pieces of wood 1" x 1" x 13", and bevel a corner the length of each piece. Then join the 4 pieces. Either method provides a channel for the pipe which will carry the wire up the stem.)
b. Match the grooves and glue the stem pieces together. Follow instructions on the glue container so you’ll clamp the stem properly and let it dry long enough.
Now assemble the lamp:

- Center the stem over the hole in the upper half of the base and secure it from underneath with two wood screws. Countersink the screws.
- Insert the pipe into the stem and top half of the base. Remove the socket cap from the light socket and screw it onto the pipe at the top of stem.
- At the bottom of the stem, place the lock washer and nut on the pipe. Tighten the nut.
- Thread the lamp cord through the hole in bottom half of the base and up through the top half of the base and stem. Pull the cord well up through the stem and knot it loosely so it won’t pull out when you assemble the base. Strip the insulation from the other end and attach it to the plug by tying a knot.
- Center the stem and upper half of base over the hole in the lower half of the base. Glue the base together. When it is dry, secure the base from its underside using one wood screw at each corner. Countersink the screws.
- Now untie the loose knot in cord at top of stem. Strip the insulation from ends of each wire and tie a knot again. Fasten it to the screw terminals of the light socket.
- Assemble the socket and screw the shade holder onto the socket.
- Fit the diffusing bowl on the shade holder. If you use a threaded plastic diffusing bowl, the shade holder will not be needed.
- Insert the bulb, and place the shade on the completed lamp.

Variations you can make:
You can finish your wood lamp with colored enamel, shellac, stain, or varnish. Or you may want to cover it with imitation leather. You can vary the stem and base of your lamp to achieve different pleasing designs. Or perhaps you would like to make your own lamp design, using the same length stem and same size shade, diffusing bowl and bulb. Work out your design in detail and show it to your leader before starting to work.

IV. Heating Appliances

Although electricity serves us most obviously through lighting, most of its “little miracles” done to ease our work load at home are accomplished by the many kinds of electric appliances.

When electricity first arrives at our homes, it is “raw energy”. To be useful to us, it must be converted into another form of energy by the various home appliances.

Most appliances convert electrical energy into either heat (as in the case of toaster, iron, etc.) or motion (as in the case of vacuum cleaners, fans, mixers, etc.). Some cause cooling, which actually involves moving heat from one place to another.

Do you realize how many electrical appliances in your home produce heat? This heat helps toast bread, perk coffee, brown waffles, grill sandwiches, sizzle steaks, press out wrinkles and dry your hair.

We saw earlier in the Electric Energy program how heat is produced. Electric current is forced through a material with a high resistance to the passage of the current. By choosing a material with resistance high enough for the heating elements of an electric heating appliance, and by including the proper controls, we can turn electric energy into heat energy whenever and wherever we wish.

Let’s take a closer look at some common electric heating appliances.

1. **Cooking with Electric Heat**

All electric heating appliances have two things in common: a heating element for converting electrical energy to heat energy through resistance, and a control. These are arranged in the shape necessary to do the job for which the appliance was designed.
How does the heat get from the heating element to the food?

In ancient times, people thought that heat was a material just as air is. They called it "caloric." When something got warm, they said caloric flowed into it. When something cooled off, caloric flowed out of it.

Today, of course, we know that heat is not a material, but a form of energy. We know it travels from one body to another by three methods: conduction, convection or radiation.

Conduction occurs when you set food or a pan containing it right on a heating element — such as a portable electric frying pan with the heating element built right into the pan. An egg cooking in a hot fry pan is a good example of conduction at work. This method is the most efficient single way of using electric heat for cooking.

Radiation heating is more difficult to explain. It results when invisible heat waves (which you'll remember are like light waves, only longer wavelengths) strike an object and are converted into heat. The energy we receive from the sun is a good example. The air may be cold, but we can feel warmth on our cheeks even on a crisp, clear winter day. This is radiant energy. The electric heat lamp is one of the most familiar sources of radiant heat. Radiant heat energy is used in cooking in devices like broilers and toasters.

Convection warms food in pans that are not actually touching the heating element. It uses the hot air around the element to carry heat to the pan. The oven in your range works by convection.
Most of us are familiar with electric ranges. These are large but fairly simple appliances that provide heat for cooking all three ways: by conduction through heating elements on the top surface, by convection in the oven and by radiation in the broiler. Controls regulate the amount of current that flows through the heating elements. The more current, the higher the heat. “Low” or “simmer” positions on the controls provide less current. Thermostatic controls, which turn the current on and off at pre-set temperatures, keep the oven at a certain heat level for baking. In addition, many ranges are provided with timer controls that can allow the oven to be turned on and off at a pre-determined time, so that you do not have to be present. An electric range is always wired into a separate circuit with no other appliances on the circuit.

Portable electric cooking appliances probably rank even higher than electric ranges as convenience items. Of course, as with electric ranges, we must have some means of controlling the heat. Most appliances use thermostats for this purpose. They let you select the best temperature for cooking and keep the appliance at that temperature automatically until the job is done. This controlled heating assures you that the food will not burn (unless you leave it too long), and that it will be done in a reasonable length of time.

A thermostat can be “calibrated”, or set, so that you can dial exactly the temperature you want to be maintained. Sometimes, instead of temperatures, the names of certain foods are printed on the thermostat control. When turned to one of the positions, the thermostat will maintain the best pre-determined cooking temperature for that food.

Most appliances have a dial indicator or pilot light which lets you know when the temperature you’ve selected has been reached.

Some appliances have the heat control attached to the cord which is detachable from the appliance. This feature usually means that the appliance can be immersed in water for easy cleaning. For proper cleaning methods study the use-care manual that comes with your appliance.

There are some rules which you should follow in handling such a cord. When finished with the appliance, adjust the automatic heat control to the OFF position, and then disconnect the cord from the wall outlet. To avoid burns, cool long metal rod or probe extending from the control before handling.

The toaster is one of the most common electric appliance. The heating element in most toasters is a nichrome wire that is wound around a sheet of mica. As electricity flows in the wire, it heats up to provide the heat needed to toast the bread.
Two basic types of toasters are available. The pop-up toaster can be found in both two-slice and four-slice models. The “toaster oven” type holds the bread horizontally, and is more versatile for toasting bread, muffins and rolls of various lengths and thicknesses.

**POP-UP TOASTER**
- **Toast Slots**
- **Control Levers**
- **Hinged Crumb Tray Underneath**
- **Two Toast Color Selectors**

**TOASTER-OVEN**
- **Oven Temperature Settings**
- **Removable Horizontal Toaster Rack**
- **Crumb Tray Underneath**
- **See-Through Door**
- **Heat Resistant Handle, Feet**
- **Signal Light**
- **Top Brown Setting**
- **Toast Color Control**

Electric cooking appliances can become such a part of our daily routine that we often fail to realize that we can use them creatively. For example, how many of us ever try all the recipes or suggestions given in the instruction book with a particular appliance?

If you have a griddle, for example, you could surprise your family with a different grilled sandwich or use it to keep the serving dishes warm at the table. Maybe you could make use of an outdoor outlet and use the appliance for cooking supper there.

2. **Ironing With Electric Heat**

Wearing clean, wrinkle free clothes is an important part of looking your best for dates, job interviews and special occasions. Fortunately, today’s permanent press and other easy-care fabrics means ironing is easier than it used to be. However, some other fabrics still need ironing and even permanent press requires an occasional touch up. There will come a time when you’ll need to know how to handle an iron to get your clothes in the best possible shape.

There are two kinds of irons; the dry iron and the steam iron.

The dry iron presses with heat only. If you need moisture to help remove the wrinkles, you have to sprinkle or dampen the clothes.

The popular steam or “steam-and-dry” iron holds about a cupful of water in a reservoir. Distilled water is recommended in many irons, as mineral build-up can lessen the efficiency of the iron. The water is turned to steam inside the iron, and comes out through the holes or vents in the “soleplate.”

The soleplate is the part of the iron that touches the clothes as you iron and contains the electric heating element. Since it touches the clothes, the soleplate should be smooth, well-polished and rust-resistant. It may be made of aluminum or stainless steel, and is sometimes coated with a slick plastic-like material to make it glide more easily. Vents (holes in the soleplate) allow steam to come out. These vents must be kept clean and open.

Most modern irons have a thermostat which turns the electricity off and on automatically to maintain the proper temperature for different kinds of fabrics. A dial found on the modern iron indicates type of fabric instead of degrees of temperature.

Your iron will be rated at least 1000 watts, and probably more, so you will need to connect the iron to a 120-volt circuit that is not already loaded to capacity. Plug the iron directly into a convenient outlet. If you must use an extension cord, be sure to use one that is made for use with heating appliances. Small common
extension cords made of #18 lamp cord will not do the job — they cannot carry the amount of current demanded by the iron. The extra electrical resistance in the small cord causes the cord to overheat and the iron has to operate at a reduced voltage. The iron will not heat efficiently. If you need an extension cord, be sure it is made of adequate size wire (#16 or larger) and not too long. Always be sure to turn the iron off and set it back on the heel of the soleplate whenever you must leave your work — even if for just a few minutes.

3. Space Heating

Electricity has been widely used for many years to help keep people warm. It does so in the same way that it cooks our food and irons our clothes — through resistance heating.

Electric heating has the advantage of being easily installed or placed in unusual locations, as simply as plugging a cord into a convenience outlet. It has the ability to be portable, such as through portable “bathroom” heaters.

It helps us keep our homes cleaner by eliminating the need for chimneys, smokestacks, and fuel storage. Electric heat systems also usually cost less to install and maintain than oil or gas systems. Since there is a reduced fire hazard with electric heat (there are no open flames), insurance costs for an electrically heated home are often less.

The disadvantages of space heating are that it heats at greater operating cost, cannot provide heat in times of an electrical power failure, and in the case of portable heaters, requires more safety precautions.

There are several types of electric heating systems.

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Central, forced air heating is quite common. Here, a central unit provides heat from a large resistance heating element, and a fan moves the warm air to different rooms through a duct system. Electric heat of this type is common where an electric “furnace” has replaced an oil, gas or coal-burning unit and duct work is already in existence. It is also often used when the heating system must share the ducts with an air-conditioning system.
**Baseboard Heaters** Electric heating is practical for a whole house or building. Room-by-room resistance heating is a very common method — also often called “baseboard heating” because of the typical placement of the heating units along a wall at floor level. It has many advantages:

1. No air noise
2. A blanket of warm, comfortable air
3. Space saved — no larger furnace needed
4. Low installation costs — no duct work, plumbing, flues, or vents
5. More uniform heat
6. Cleaner heat — no quantities of air moving to deposit dust and dirt on walls and furniture
7. Individual rooms kept at desired temperatures by a thermostat in every room
8. Very little maintenance on the system (no moving parts)
9. Units located in strategic locations (such as under windows where cold air drifts downward from the cold window pane)
10. No usable wall space taken up: units can be painted to match room decor

**Heat Cable** is installed in the ceiling and covered with a thin layer of plaster or paint. It distributes radiant heat evenly over the desired living area. The cable is also sometimes installed in a concrete slab floor. No space is required, and furniture can be placed anywhere.

**Electric blankets, heating pads, hair curlers, heat massagers, hair dryers — all are typical heating appliances we know and use.**

5. **Insulation**

All heating appliances must use “insulation.” Yes, obviously, the electrical parts must be properly electrically insulated to keep the electricity flowing in its proper path. However, you can insulate against heat, too.

Some materials transmit heat more readily than others. You know this from holding a metal rod in a flame too long. The end of the rod soon gets too hot to hold. If you hold a wooden rod in a fire, this won’t happen. The end of the rod may catch fire, but the opposite end you are holding won’t even become warm (unless you hold it long enough for the wood to burn down to your hand!).

“Insulation” is another type of material that retards heat flow. It is important in most heating applications because it slows the loss of heat, and protects the operator of the appliance from being burned. Handles of frying pans and other appliances are made of insulating material — often a heavy-duty plastic.

Ovens in electric ranges are surrounded with insulation to keep the heat in the oven where it belongs. Insulating material is built into walls and ceilings of homes to retain heat in the winter and to keep it out in summer.

**Things To Do**

1. **Make Popcorn Two Ways**

Show how things cook by convection, conduction and radiation by making popcorn two different ways. You’ll need the following material:

- Popcorn
- Cooking oil
- Salt and butter
- 4-quart saucepan with glass cover
- Pot holder
- Electric range
- Two 250-watt heat lamps
- Two spring clamp type lamp holders
- Wire mesh corn popping basket (or wire mesh kitchen strainer with an improvised screen wire cover).

**First.** Make popcorn the usual way. Set a surface unit control of the range to “medium high”. Pour enough oil to very lightly cover the bottom of the saucepan. When the oil is hot, pour in enough popcorn to cover the bottom with one layer of kernels. Use the pot holder in
one hand to hold the cover on and with the other hand move the pan back and forth across the unit. When the popping stops, remove from the heat.

How did the heat get to the pop corn?

Second, make popcorn with the heat lamps. Clamp the holders to the back of a chair or other vertical support. They should be 6 to 8 inches apart and point directly at each other. Put about 2 tablespoonsful of popcorn in the wire basket or strainer. Do not add oil. Hold the basket midway between the two lamps. When the popping stops, turn off the lamps.

What kind of heating was this? Butter and salt the popcorn you have made and share it with others as you discuss ways heat travels.

2. Cooking Appliances

Make a list of all the electric cooking appliances in your home. Choose at least one of the appliances and tell how many ways you are able to use it. If possible, show how to fix a snack for the club on it. Show how you clean and take care of the appliance. Write down and explain the information on the appliance name-plate. Study over its instruction book and explain what topics are covered in it.

3. Using The Electric Iron

a. For a month, keep a record of what and how many articles you iron. Make a chart with five columns headed “date”, “type of article ironed”, “fabric”, “number ironed” and one to check if you “stored the iron” when finished. You may be surprised how often the iron is used.

b. Show the difference between a steam-and-dry iron and a dry iron and how each is used.

V. Motors Instead of Muscles

The other major class of appliances substitutes electric motor power for muscle power to help us do many household chores more quickly, efficiently and thoroughly than by hand.

You will likely think of many appliances that do their job through the force or motion of electric motors: vacuum cleaners, floor scrubbers/polishers, food mixers, blenders, fans, blow dryers, washing machines and others.

All of these types of appliances have two things in common: an electric motor to convert electrical energy into the motion or force we need, and a control to regulate the speed at which the motor does its job. The remainder of the appliance, of course, consists of the parts and attachments which convert the motor’s force into the exact form we need for the chore that has to be done.
There are many types and sizes of electric motors, but all work in much the same way.

There are two main types of washing machines — the tub-type (such as agitator or “top-loaders” types) and drum-type (“front-loaders”).

In all tub-type machines, the load to be washed is moved about suspended in water. In an agitator machine the movement is produced by fins or blades slowly revolving on a central shaft. Some types, however, eliminate the agitator and use water jets to move the clothes.

In the drum-type machines, a perforated drum is rotated inside a tank. Projections inside the drum cause the clothes to drop back into the water as the drum revolves.

Fully automatic washing machines of either type can pre-soak, wash, rinse and spin dry clothes with no attention from the operator after the load is placed in the machine, the power switched on and the timing device set.

Let's look at some of the equipment inside an automatic washer to see just how it operates.

The inflow of water and the water level in the tank is controlled by a pressure switch. The switch is made of a diaphragm that is forced upward as the pressure under it increases and that operates an electrical contact when the predetermined pressure (and thus depth of water) has been reached.

Water level in tub affects pressure in sensing tube (1), raising or lowering diaphragm (2) to point where control setting allows electric contacts (3) to pull apart or come together. Current cuts off or begins to flow causing electromagnet (4) to release or pull in plunger (5), closing or opening water supply valve (6).

Automatic washers have a “program control” unit which puts out electric impulses to control the various operations that the machine performs. It is composed of a small electric motor, a reversing mechanism, washing time selector, a step-by-step switching device and a “programmed” switching device.

The electric motors in small appliances are built similarly and are usually quite small. Since they are built into the appliance, you can't see them unless the appliance is disassembled.

The motor is often controlled by a variable speed control for the specific task in mind. These controls are often simply variable resistors which act to increase or decrease the amount of voltage reaching the motor. Sometimes speed controls are a bit more complicated and actually change the windings on the motor.

Let’s examine more closely some typical motor-driven appliances we use at home:

1. **Washing and Drying Machines** Perhaps the largest motor-driven appliance you’ll find at home is a clothes-washing machine. These, of course, use motors to pump water in and out of the wash tub, as well as to spin or “agitator” during wash and rinse functions.
Program motor turns slowly, rotating cams, which trip different selector switches in pre-set order to start and stop washing and rinsing cycles.

Modern washing machines are equipped with a number of safety devices. The rotation of the drum, especially on the high-speed spin-dry cycle, is automatically switched off when the cover is opened, and a magnetic brake quickly stops the motion, so there is no danger of the operator's hand being caught.

Automatic dishwashers work in similar fashion, but, of course, do not fill with water.

Electric clothes dryers combine heat and motion from electricity to dry clothes once they are washed. They are really fairly simple appliances, with a heating element that works like the element in an oven, and a motor or motors that rotate a perforated drum containing the clothes while blowing warm, dry air over them. Dryers, too, can have special controls that regulate the drying process, such as timer switches and thermostats.

Washing and drying machines together have probably done more to eliminate household drudgery than any other single appliance.

2. **Vacuum Cleaners** Every vacuum cleaner has four basic parts — fan, motor, filter-bag and nozzle.

   The fan creates the air suction that draws dirt into the nozzle of the cleaner. The motor drives the fan. The filter bag traps the dirt and dust, returning clean air into the room.

   A central vacuum cleaner features a hose that is plugged into a wall socket. There are also two types of portable vacuum cleaners, tank and upright. The tank type, also called "cannister," cleans by suction through a hand-held nozzle at the end of a hose, with or without brush attachment. The filter stops the dust and traps it in a collecting chamber. The upright type cleans as it is pushed across the floor by suction, and sometimes has a motor-driven brush or "beater" that helps dislodge the dirt from carpet fibers. The filter bag is exposed and is somewhat easier to replace than the collecting bag of a tank-type vacuum.

   The suction of any type of cleaner depends a great deal on how clean the bag is. The air must be able to filter through the bag in order to produce the suction upon which the cleaning depends. You should empty the bag often, discarding disposable paper ones.

3. **Food Mixers**. Food mixers are either of the "standard" type or the portable type. Standard mixers are good for heavy-duty work such as mixing stiff batters or mixing for long periods. Portable mixers are good for lighter mixing jobs where a heavy standard mixer would be inconvenient.

   All mixers are rather simple, consisting of a motor and a speed control to vary the mixing speed.

**Things To Do**

1. **Appliance Survey**

   Start in the kitchen and go from room to room, making a list of all electric appliances. Don't forget those stored in cabinets or closets. Once you have the list, try to locate the instruction books for each. Write to the manufacturer for those you cannot find. Keep them in one place until Lesson VII. How many total watts of "appliance power" do you have?

2. **Motor Survey**

   Write down the names and uses of all appliances in your home that use electric motors. Before you identify them, see if other family members can guess the correct number.
VI. Cooling with Electricity

As mentioned earlier, electricity cools essentially by removing heat from where it is not wanted. Electric cooling has enabled all of us to live as royalty, with cool drinks and fresh food from all parts of the world stored right at home in our refrigerators.

The household refrigerator is really a simple mechanism that works much like a tea kettle boiling on a range. That may seem farfetched, but actually a refrigerator cools only because a liquid inside it boils.

To start with, we should understand that there is no such thing as "cold." Cold is simply the lack of heat. Your feet on a winter day are uncomfortable only because heat has been taken away from your shoes. We can’t make things cold directly, but we can remove heat they contain. As a result, they will become cold. This is the main job of a refrigerator — a device for removing heat.

The next thing we should know is that heat only moves one way — from a warm object to a colder one. When you hold your hands out toward a fire, heat flows from the hot fire to your cold hands. When you make a snowball, heat always flows from your hands to the snow. In a refrigerator, the freezing coils are colder than the stored food, so heat flows out of the warm food to the coils. It may seem at this point that we have drifted into a story about heat instead of refrigeration. But, in doing so, we have learned how heat moves. And this is just what refrigeration is — the movement of heat.

Whenever we think of anything boiling, we tend to think of it as being very hot. But this is not always true. Water, of course, boils at a relatively high temperature: 212° (100° C). However, pure ammonia boils at 28° below zero! (-33° C) This means ammonia will boil while sitting on a cake of ice! (Note we are not talking here about household ammonia often used in cleaning, which is so diluted it is practically water.)

The key to refrigeration is that some substances are a liquid at certain temperatures and pressures, and a vapor at others. The transition from liquid to vapor is called “boiling.” If we heat water in a tea kettle, the thermometer tells us that the water gets hotter until it starts to boil. Then the mercury seems to stick at the 212° (100° C) mark. Even though many won’t believe it, the water won’t get any hotter than this unless you confine it tightly as you do in a pressure cooker. As a liquid is changed to a gas — that is, as the water is turned into vapor or steam in our example — large amounts of heat are absorbed without any increase in temperature. This is called “latent heat of vaporization” — or simply the “hidden heat of evaporation.”
If ammonia is allowed to boil, just as water was boiled in the tea kettle, it will absorb large amounts of heat from its surroundings. Remember, to the ammonia, room temperature is just as hot as a stove element on “high” is to water.

If you put a jar of ammonia inside a refrigerator cabinet, it would boil, taking heat from everything around it. This makes ammonia a “refrigerant.” In fact, at one time ammonia was the most popular refrigerant used. Today, better and safer refrigerants are manufactured.

Now we can begin to see the similarity between a boiling tea kettle and a refrigerator. Both draw in heat to boil although they do so at different temperature levels. Refrigerators are very much like ice coolers. Water from the melting ice carries heat out of an ice cooler, while refrigerant vapors do the same job in a refrigerator.

If a refrigerator is allowed to boil inside the pipes within the refrigerator, it will pick up heat. The vapor produced must be carried out of the refrigerator storage area. The vapor is too expensive to let it float away into the air, however. Some way must be found to remove the heat from the vapor and change it back into a liquid, so it can be used over again. How can you cool the gases so they will turn back into a liquid, leaving only room-temperature air? It seems we haven’t yet solved our cooling problem—just moved it outside the refrigerator!

This is where pressure comes to the rescue. With pressure, we can compress the vapor, thereby concentrating the heat it contains and raise its temperature without adding heat. You may have noticed this effect in how a bicycle tire pump gets hotter as you pump up a tire. With enough compression, we can make the refrigerant vapors so hot that the heat from them can flow into the comparatively cooler room-temperature air surrounding the refrigerator. (Remember heat always flows from the hotter material to the cooler material.) This effect is helped by pumping the hot vapors through a radiator-like device called the condenser that helps remove the heat.

Removal of heat in the condenser causes the refrigerant to turn back into a liquid. From there, the cooler refrigerant flows through an expansion valve. The valve causes the pressure to be lowered back to the original level it was before going through the compressor, and in the process causes the refrigerant to drop in temperature even further. Finally, the refrigerant re-enters the evaporation coil and the cycle starts all over again.

Any refrigerator, freezer, cooler, or air conditioner works about the same way. There are three main parts: evaporator coil (inside the refrigerator), compressor (operated by an electric motor) and the condenser. The evaporator provides a place for the refrigerant to boil and absorb heat from the refrigerator storage compartment. As the refrigerant turns to a vapor, it is removed from the evaporator. If you listen carefully with the door open and the motor off, you can hear a faint gurgling noise inside the refrigerator. This is the sound of the refrigerant boiling and changing into a vapor.

The compressor is driven by an electric motor. It exerts pressure to concentrate the vapor (which is still pretty cold) and this makes it hot enough to lose its heat in the condenser, thereby changing into a liquid again. With the addition of a flow valve and electrical controls, refrigeration devices operate automatically.

Like an electric oven, a refrigerator cabinet is surrounded by insulation to control the heat. Of course, the difference is that oven insulation is to keep the heat in, while refrigerator insulation is to keep the heat out!

**Things To Do**

1. **Refrigeration** To make something hotter without adding heat, use pressure. Blow up a tire with a tire pump. Have someone feel the pump. Explain how this shows the principle of the operation of a refrigerator compressor.

2. Program and describe the “refrigeration cycle” using blackboard and chalk.

3. Collect pictures of refrigerants used in times past, and use them in a historical report.
VII. Electronic Appliances

For many years, electricity did its work around the house in only three ways: by producing light energy, heat energy, and motion or force through electric motors.

As science has increased our knowledge of electricity, more devices which use electricity in different ways find their way into home use. Often as a result of research done in medicine, space travel or other fields, new inventions come about which enterprising businesses turn into new types of appliances for the home or for our entertainment.

Most of these newer devices use the science of “electronics” to do their wonders. Electronics involves the very careful control of electron flow — far beyond the switches, thermostats, and fuses we have already discussed — to make electricity do special and amazing things. Electron tubes, transistors, integrated circuits — names you have probably heard quite often — are all electronic devices.

The first by-products of electronics to be used in the home were telephone, radio and television. Of course, these are nothing new to us today, but they actually revolutionized home life when they came into being in the early 1900’s, 1920’s and 1950’s, respectively.

These devices made communications much easier by transmitting sound, and later pictures.

Most electronic devices that transmit or reproduce sound waves work basically alike. This is, sound is turned into an electric current which varies, or changes, in step with the pitch of the voice or music being transmitted. This current is then “broadcast” in some way to a receiver. The receiver reproduces the varying electric current, which is turned back into sound by a loudspeaker. Telephones and home intercoms, use this method, relying on wires to transmit the varying electric current.

You’ll remember from our discussion on light that heat, light, radio and TV signals and even X-rays are the same type of energy — electromagnetic radiation. The only difference between them is wavelength.

They also differ according to “frequency.” Frequency is the number of times per second that a wave completes one full cycle — that is, goes from zero to the maximum positive value, back through zero to the maximum negative value, and back again to zero.

In alternating current (AC), a similar wave form illustrates how the current flows first in one direction then in the other. AC electricity makes 60 full cycles in one second. We say its “frequency” is 60 cycles per second. “Cycles-per-second” is also called “Hertz”, so 60 cycles per second is also 60 Hertz.

Radio works in much the same way, except the wires between the “sender” and “receiver” are eliminated. That’s why the first radio sets were called “wireless”. In place of the wires are electromagnetic waves.

Electromagnetic energy travels in similar waveforms, but its frequency is much higher — measured in thousands or millions of cycles per second.
Radio

Each radio station is assigned a certain frequency. This means it can only broadcast electromagnetic waves at the frequency — none other.

By turning your radio dial to the correct number, which represents the number of cycles-per-second, or Hertz, you can match the frequency of a certain radio station and pick up its “signal.”

How do radio stations broadcast music and voice over that invisible electromagnetic bridge to your radio?

One way is to vary the amplitude, or strength, of the electromagnetic wave in step with the changes in pitch of the voice or music. This method is called “Amplitude Modulation” (Modulation means “change,” and “amplitude” means “strength,” so amplitude modulation simply means “change in strength”). It is often simply referred to as “AM.” You are probably very familiar with some favorite “AM” radio stations that use this method.

Another way is to vary the frequency of the electromagnetic wave within a narrow range on either side of the “base” frequency assigned to the station. This method is called “Frequency Modulation” (meaning “change in frequency”), and is often called “FM.”

When your radio is turned to the base frequency of a particular station, electronic devices sense the amplitude variations (AM radio) or frequency variations (FM radio). These devices change the variations back into an electric current that varies in step with the music or voice being broadcast. The devices amplify or strengthen this current, and finally the loudspeaker converts the varying current back into sound waves.

The first radios used large bulky electronic tubes to sense AM or FM signals and amplify them. These tubes were built much like light bulbs and had a vacuum in them. Today, most radios use “solid state” electronics — meaning the electronic devices contain no gases or open spaces as in a tube — such as transistors.

Television

The sound portion of a TV program is broadcast and received just like an FM radio program. Nothing different there.

The real difference, of course, lies in the broadcast of the picture.

TV uses the same principle that makes movies work — that is, you are shown a large number of still pictures, each one of which may show a person or object in a slightly different position, in so rapid a succession that you get the impression of seeing one continuous motion. A TV screen actually “paints” 30 different pictures per second.

A TV picture tube is much like a simple fluorescent light tube. In both fluorescent lights and TV tubes, a hot element called the “cathode” emits a stream of electrons into the tube.

In a fluorescent light, ultraviolet rays (caused by electrons striking atoms of mercury floating in the tube) strike phosphorescent chemicals coating the tube, causing them to glow.

In a TV tube, the electrons themselves strike phosphorescent chemicals coating the inside of the screen, causing the screen to glow. Also, in a TV tube, the electrons are focused into a narrow beam instead of just scattering.
The electron beam moves back and forth and up and down across the TV screen, covering it completely 30 times per second, and causing the whole screen to glow.

The picture is made much like a picture in a newspaper.

Look closely at a photo in a newspaper with a magnifying glass. You will see it is made up of many tiny dots—some larger, some smaller. When viewed from a normal distance, the dots merge to produce larger patterns of light and dark spaces. The larger the dots in an area, the darker the area seems to be; the smaller the dots, the lighter the area.

The electron beam "assembles" a picture on a TV screen much the same way. A "dot" of light appears on the screen wherever the beam touches it. If the beam is intense, the spot will be bright. If it is not intense, the spot will be pale. If the beam is zig-zagged across the screen, a series of luminous dots of varying brightness are produced in rapid succession on the screen. All together, the dots make up areas of brightness or darkness that the viewer sees as a picture.

The electron beam is caused to zig-zag across the screen by electromagnetic coils. The coils are energized in a set sequence, creating a magnetic field that varies in an exact pattern. The magnetic field deflects the stream of electrons from the cathode, or electron gun, of the tube in such a way that it zig-zags back and forth across the screen.

The picture is controlled by varying the electric current to the electron gun of the tube, causing it to put out electrons in greater or lesser intensity as it "scans." or zig-zags back and forth.

Back at the TV station, a special camera scans the picture being broadcast, and turns it into a varying electric current according to the light or dark areas in the scene. This varying current is then turned into an "amplitude modulation" (AM) signal that is broadcast.

Tuning your TV set to the proper base frequency of the TV station enables it to sense the amplitude variations in the signal and turn them back into an electric current. This current, in turn, varies according to the light and dark areas of the picture being broadcast. This varying current flows through the electron gun in the picture tube, causing the electron beam to be stronger or weaker, again according to the light or dark areas of the picture. The beam then "paints" the scene on your TV screen.

Color TV works generally the same way, except three different electron "guns," or cathodes, are used to paint electron "signals" which are controlled by three basic colors: red, blue, and green. The colors are mixed on the screen to paint a color picture.

Phonographs and Tape Recorders

Phonographs and tape recorders produce sound much like a radio. The whole idea is to produce an electric current that varies according to the pitch of voice or music, and then to amplify and turn this varying current into sound waves with a loudspeaker. The difference is the source of the signal and how it is converted into varying electric current.

In the case of a phonograph, a needle rests in a narrow groove cut in the record. The groove, of course, is a spiral that starts from the outside edge of
the record and spirals in to the center. By turning the record, the phonograph needle will follow the groove from start to finish.

The edges of the groove are not smooth, but wavy. As the needle follows the groove, the wavy edges of the groove cause the needle to vibrate back and forth. Actually, the needle is vibrating in step with the pitch and volume of the music recorded on the record. This is because the edges of the groove in the record were made to be “wavy” in step with the pitch and volume of music.

A magnetic pickup works much like a miniature electric generator. The needle is attached to tiny coils of wire. These coils are suspended in a magnetic field. As the needle vibrates, the coils move back and forth in the magnetic field. This produces an electric current in the coils (you'll remember a wire moved through a magnetic field has an electric current induced in it). The current varies in step with the vibrations of the needle.

Tape recorders use magnetism to reproduce sound, too, but in a different way.

To produce a tape recording, sound (music or speech) is converted into varying electric current. This current causes a magnetic “recording head” to produce a magnetic field of varying strength, in step with the variations in the current.

This varying magnetic field magnetizes a tape along its length according to the original variations in the electric signal.

The tape is plastic, coated with millions of tiny needle-shaped iron or chromium particles, each about a millionth of an inch long. Each particle becomes a virtually permanent magnet as it is passed through the magnetic field of the recording head. The stronger the field when a given particle passes the head, the stronger a magnet the tiny particle becomes.

When the recording is done, you then have a tape with all of its particles magnetized to varying strengths along its length, in a pattern according to the original sound waves.

To reproduce the sound, the magnetized tape is passed over another coil, called the “reproducing” or “playback” head. The changing magnetic field, caused by the passage of the many tiny magnets of varying strengths in the tape, induces a varying electric current in the coil. This current, as you might guess, varies in step with the pitch and volume of the music or voice originally recorded.
Microwave Ovens

One of the latest devices bringing electronics into home use is the microwave oven, the first entry of electronics into the world of cooking.

“Microwave” is just another name for electromagnetic radiation of very short wavelength and very high frequency.

In a microwave oven, electrical energy is transformed into electromagnetic energy by an electronic tube called a “magnetron.” This tube is much like a radio broadcasting station, sending out high frequency waves into the oven. Metal walls of the oven reflect the waves and keep them from getting outside.

The electromagnetic waves are absorbed by food placed in the oven, and cause the molecules to vibrate. This vibration causes friction, which in turn produces heat, and causes the food to cook.

Microwave ovens have several advantages:

1. All the heat is produced in the food. No heat is wasted in pre-heating the oven or in heating utensils, oven walls, baking dishes, etc. Spatters and spills don’t bake on, making clean-up easier.

2. Microwaves cook much faster — as much as three times as fast as conventional cooking methods. Some foods retain their natural flavor and vitamins better, if a small quantity is cooked.

3. Microwave cooking does not heat up the kitchen like regular ovens.

4. A microwave oven can be used to “flash defrost” foods stored in your freezer.

5. Microwave cooking uses less energy when small amounts of single items are cooked. (When cooking for four or more people, you may want to use a conventional oven to gain more space for the same or a lower amount of energy.)

Things To Do

1. Study the fascinating history of the invention of the telephone, the radio and the television. Make a report on one of these to the group.

2. Compare the efficiencies of electronic appliances with those of other systems around the home. For instance, in what cases does the microwave oven heat more efficiently than a regular oven, and in what cases does it not?

3. Explore the world of stereo. Learn how receiver and speaker systems work, and what are the best room arrangements for producing fine tonal quality in music and voice. Learn how to match components. Draw a chart that shows where you would place receiver and speakers.

4. Visit a retail store or repair shop to find out from professionals what new electronic appliances will be appearing on the market in the future. Watch them as they repair damaged equipment. Discuss with them the future of electronics in the home. Will there be increasing career opportunities in this field?

VIII. Choosing and Operating Appliances

Electrical appliances — large and small — must occasionally be purchased for your own use or as a gift. Shopping for an electrical item can be fun; but remember, when buying an appliance you'll want to get the best appliance for your money and for the purpose you had in mind.
Some things to consider are:

1. **Design** Has it been designed for easy operation and use? Will it be easy to take care of? Does it have easy-to-reach controls? Are the controls marked clearly? Is it the correct size, and does it have the proper features to meet the needs you have for it? Does it have features that you won’t use and which may represent an extra source of maintenance trouble? What will the initial and maintenance costs be?

2. **Power Requirements** Some appliances need a lot of electric current. For example, a four-slice toaster takes 1,500-1,600 watts, and may need a separate circuit. Do you have such circuits available? Where would the appliance normally be used?

3. **Construction** Does the appliance appear well-constructed? Will it be stable on a counter top or table? Are there any sharp edges that could cause injury? Are the legs, base and handle heat-resistant? Are the handles large and sturdy enough to easily move the appliance? Will the appliance be easy to clean?

4. **Use** Will the appliance fill your needs? Do you already have an appliance that will do the same thing? Would you use it often enough to justify buying it?

5. **Safety** Your best assurance of safety is the seal of the Underwriter's Laboratories (UL) on or near the nameplate of the appliance. As noted before, the UL seal guarantees that the appliance meets minimum safety standards when purchased, and when used as intended.

6. **Brand Name** Is the appliance made by a known manufacturer? Does the manufacturer have a reputation for good quality and durability?

7. **Energy Use** Does the appliance use energy efficiently? Is it the proper size for the job? Does it have energy using features which you really won’t use? For example: “Frost free” refrigerators and “instant-on” TV’s use more energy. How important are these features to you?

8. **Warranty and Service** When buying an appliance check the warranty for: a) length of time of guarantee for free replacement parts, b) length of time that service labor is free, c) where the appliance must be sent for free repairs. If an appliance must be shipped to some distant place at your expense for “free” repairs, paying for repairs made closer to home may be less expensive.

When you purchase an appliance, you will often receive a warranty or guarantee card that should be filled out and returned to the manufacturer. Be sure you have completed all forms or cards needed to put the guarantee into effect.

9. **Storage** Is the appliance compact for easy storage? Are there provisions for storage of accessories?

10. **Use and Care Book** Is a use and care book included? Is it complete? Is it easily understood?

If you are planning to buy an appliance, either for yourself or as a gift, you can organize information so you can select the best one for your needs. If you wish, you can fill out a table such as the one below to help you make your decision.

What are some of the sources of information you’ll want to consider in making your buying decision? There are lots of sources to consider.

1. **Talk to users.** Ask others who own this type or brand of appliance how much they use it, whether (or how long) it has performed satisfactorily for them and whether they have been able to get service promptly. Be sure to evaluate such information carefully. It’s possible the person you are checking with has an older model of the appliance that may have been improved.

2. **Read the ads.** Advertising is the means that manufacturers use to tell us about their products. These messages tell us much about the products' appearance, its features, it capabilities and its cost.

Advertising is especially helpful as a source of information about new products, product improvements, new uses, price changes, where to buy and techniques for care and maintenance. On the other hand, it will rarely inform you about problems you may encounter with the appliance.

3. **Study manufacturers’ literature.** Much more complete than most magazine and newspaper advertising are the folders and brochures prepared by manufacturers. Usually included are specifications, sizes, colors, and complete descriptions of the product’s features.

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**Choose Your Appliances Wisely**

- Refrigerator
- Blender
- Coffee Maker
- Toaster
- Vacuum Cleaner
- Stove
- Dryer

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Special models and optional accessories — things that may meet your needs exactly — are described in such literature.

4. Study the catalogs. Many retail stores, mail-order houses and premium companies publish catalogs which give some information about electrical items.

5. Visit the stores. You can see, examine and ask questions about appliances and the service on them in the dealer’s store. If there is a special price on the item, this is where to find about it. Allowances are made for trade-ins on some major items which you may wish to check into. Visit several stores. Read labels and information tags. Ask for literature. Make notes on prices, guarantees and service.

6. Read consumer testing reports and research publications. These publications will give you information on specific makes and models of items. They include test results, costs and guides to shopping. Ask your librarian or your Home Economics Extension Agent for information about them.

Choosing an appliance is not quite as quick and easy as you might think — if you are concerned with getting exactly what you want and the best dollar value. Buying intelligently is more fun in the long run, and you'll be more satisfied with your purchase.

Operating Appliances Wisely and Safely

Now that you have purchased your new appliance, you'll want to be sure it is properly cared for so it will give you a long life of reliable service.

Care in operating your appliance begins when you are first setting it up for use.

One of the first things to do is to read the Owner's Manual and appliance nameplate. Special instructions are often found on it (such as “Do not immerse in water”). It will tell you how many watts it uses, which will give you some idea of how many other appliances you can use on the same circuit at the same time without causing an overload. Be certain that the circuits can carry the load.

Be sure to read the instruction booklet or card that comes with the item. Avoid that temptation to use first and read the directions later. Also, fill out the guarantee or warranty card and mail it at once. Be sure to give all the information asked for. You can usually find these on the appliance nameplate. It’s a good idea to write down these numbers for your own records, such as on the instruction book.

It's also a good idea to start an appliance file for all your appliances — old and new.

When the appliances already in your home were first bought, they too came with an instruction book. Most people save such information, but sometimes it cannot be found when it’s needed most. To keep this material in one place where it can be found and referred to easily, you should make a simple file. Because this material is in different sizes, perhaps the best way to keep it all together is to use an expanding multipocket file folder (available at stationery and variety stores).

Label the section of the folder alphabetically and file the information according to appliance names. In case you can’t locate any information for some appliances, ask your dealer for it or write to the manufacturer.

You can show others in your family how to use this appliance file so that they will know where to find this information when they need it.

As new appliances come into your home, you can file the instruction book and warranty after studying them carefully. Be sure to write the date of purchase, model number and serial number on the instruction book, too.

Once you have put together your appliance file, you should read or reread all the information in it — even on your older appliances. Chances are you've never read the information before. From this reading, you will learn that each appliance is made to do a specific job, and that each one requires a special kind of care, as well as special attention to certain details that will insure wise, safe, longer-lasting enjoyment of its benefits.

The general-approach to wise and safe use of appliances is to use common sense. Some tips to keep in mind are:

1. Don’t touch live parts Keep fingers and metal utensils away from current carrying parts. For example, never use a fork to remove bread from a toaster. (If it is really stuck, unplug the toaster before attempting to remove it.) Most appliances are designed to make operative parts difficult to reach, so don’t shortchange yourself by experimenting.

2. Use only for the purpose intended. Experimenting or playing with appliances may not only ruin them, but can be dangerous. Don’t overload appliances.

3. Respect heating appliances Electric heating appliances can give severe burns or start fires. Turn them off when finished and let them cool before cleaning or storing. Watch small children when heating appliances are in use.
4. **Be careful around water** Water and electricity do not mix. Avoid using appliances in an area where they could accidentally fall into a tub or sink while still connected, or while you are standing on a concrete floor.

5. **Care for appliances properly** Good maintenance goes hand in hand with proper practices. We'll consider how to maintain home electrical equipment in a later section.

**Conserving Energy with Appliances**

When we speak of energy conservation, we mean using energy wisely.

Conservation is important. As more and more people discover more and more uses of electricity at home and in businesses, the demand for energy goes up and up. But our natural resources such as coal, oil and gas, which are burned in power plants to make electricity, are limited. Now more than ever before, we must be careful of how we use electricity so it will not be wasted. The practice of conservation helps us, and society in general, conserve energy resources by reducing the total amount consumed.

Conservation does not necessarily mean “doing” without” or enduring hardship. It does mean that you should use only what you really need, without waste. Not only will you be helping everyone in general, but there is a very good personal reason for conserving energy at home: it lowers your electric bill!

There is a lot you can do yourself to help conserve. For example:

1. **Refrigerators and Freezers** Don’t set the operating temperature colder than necessary. Defrost the freezer compartment when frost is about ¼ inch thick, or your freezer will have to work harder to maintain the same temperature. Don’t keep doors open any longer than necessary.

2. **Electric Ranges** Use the oven more often — it holds the heat in and doesn’t require the heating element to be on all the time like the surface units. Put several dishes in the oven at one time when possible. Avoid “oven peeping” — keep the door closed as much as possible while in use. Never use your range as a room heater — it’s ineffective as well as unsafe. Match the pot or pan size to the surface unit size to prevent heat waste. Use small, portable cooking appliances such as skillets when preparing small meals — they tend to use less energy. Use a microwave oven, if possible — it uses even less energy when cooking small amounts.

3. **Washers and Dryers** Wash and dry full loads whenever possible — a full cycle uses the same amount of energy regardless of how much is being washed (this goes for dishwashers, too). Rinse with cold water to save heating energy. Avoid overdrying.

4. **Lighting** The major rule for saving energy in lighting as well as all appliances is “turn it off when not in use”. There is no “surge” of power when a light is turned on, so it doesn’t hurt to turn light on and off at will. A light that is on for just a second will use just a second’s worth of electricity. Don’t let extra care in “light-watching” alone fool you into thinking you’re doing a lot for conservation, however. Lighting may be the most obvious use of electricity, but it also uses a comparatively small amount of energy. Don’t waste lighting energy, but remember the really big energy savings lie in other areas where energy use is highest — especially in the heating and cooling systems.

**Conserving Energy in Heating and Cooling Systems.**

Heating and cooling your home represents the major “block” of energy usage. One of the major actions you can take to conserve energy, therefore, is to reduce energy used to heat and cool your home.

A major step in this direction is adequate insulation to prevent wasting heat to the outside in winter, or letting heat in to overtax your air conditioner in summer.

The Larger The R-Factor, The Greater It Will Retard Heat Flow

The ability of home insulation to reduce heat flow through walls and ceilings is measured by its “R-value”, or its resistance to the movement of heat. The
higher the R-value, the better the insulation. A common form of home insulation is fiberglass formed into “blankets” built into the walls. Such blankets with a thickness of at least 3 inches (R-value of 11) is recommended for walls, 6 inches (R-value of 19) for ceilings. Since heat tends to rise, more insulation is needed on ceilings, where heat loss is greatest. If older insulation has settled, new insulation should be added to obtain the recommended thickness. Proper insulation can cut your heating and cooling energy consumption.

Energy use for heating and cooling can also be reduced by:

1. Proper caulking, weatherstripping, storm windows and doors, or double pane glass
2. Using light-colored roofing material in warm climates; dark-colored roofing material in cold climates; providing for a wide roof overhang

3. Shading windows facing east or west
4. Painting interior walls and ceilings with light-colored, reflective paint
5. Make sure heating and cooling duct work doesn’t leak by sealing joints with tape and wrapping the ducts with insulation, so that heated or cooled air won’t be lost on the way to your living area
6. Venting your attic: When it’s 95 degrees outside the temperature in your attic can be as high as 130 degrees. This layer of heat makes it more difficult to cool the living area. An attic vent fan — either wind power or electric with a thermostatic control — will pull that hot, dead air out of the attic and reduce the attic temperature by as much as 35 degrees

In the case of cooling, energy can be conserved by considering the “operating efficiency” of the air conditioner. A unit with a high operating efficiency does a more economical job.

In the case of room air conditioners, it is very easy to compute the efficiency. All the information you need is imprinted on the nameplate. With this, you can figure the “Energy Efficiency Ratio” — or “EER.” Simply divide the Btu rating by the watts of power used to arrive at EER. For example, if a 12,000 Btu unit uses 1900 watts, it would have an EER of 6.3. Another 12,000 Btu unit might use only 1350 watts and its EER would be 8.8. The higher the EER, the more efficient the unit. In our example, the latter unit is the more efficient and would cost about 28% less to operate. You will find the EER printed on the label of new air conditioners.
Window air conditioning units will be more efficient if you place them on the north or shady side of your house.

Again this is only part of the job. A complete energy conservation program involves wise usage practices as well. Inefficient or wasteful habits can defeat the advantage of even the most efficient equipment.

Many of the following pointers to help your heating and cooling systems work more efficiently are “common sense” items, but many people overlook them in the course of going about their daily business. The secret is to make these pointers part of your daily habits. It will pay off in lower electric bills!

1. Keep doors to unheated or uncooled areas firmly shut. Open and close them as quickly as possible when you go in or out.

2. Open draperies and shades on sunny winter days to let in warm sunlight while the valance board prevents cold air from circulating too freely. In summer close them to help cool your house.

3. If you have a fireplace, be sure the damper is closed when not in use, or the chimney will draw heated or cooled air from the house.

4. Keep filters clean. Dirty or lint-filled filters reduce a heating or cooling system’s air-moving efficiency. Clean or replace filters every 30 to 60 days.

5. Use heat-producing appliances (clothes dryers, cooking, etc.) in cooler times of the summer when demands on your cooling system are less.

6. Close off areas you are not using. Heating or cooling an unused room wastes money. Turn off the entire system when you plan to be away for an extended period (unless there is danger of frozen water pipes in winter).

7. Keep furniture, draperies, and other obstacles that can restrict air flow away from registers or vents.

8. Watch your thermostat setting! This is probably the single most effective practice you can adopt in saving heating and cooling energy.

First of all, keep your thermostat on a single setting during each season. Continually raising or lowering it forces your system to continually readjust to new settings.

Second, don’t set your thermostat at a high temperature in an attempt to heat up an area faster. Your system will heat your home to the thermostat setting as soon as it can. If you set it higher than the temperature you actually want, the system won’t reach the desired setting any faster. The higher setting may instead result in overheating and wasted energy.

Third, and most importantly, set your thermostat at the lowest temperature at which you are comfortable in winter and at the highest temperature in summer.

Most people find that a 65-68 degree F (20 degree C) setting in winter is comfortable. Keep in mind that every degree that you set your thermostat over this temperature range adds about three percent to your heating bill. So, if you keep your thermostat at 65
degrees instead of 72 degrees, you can save over 20% of your heating costs.

You may want to set your thermostat even lower at night. Using an electric blanket instead of heating the whole house will save you energy and money.

In the summer, 78 degrees F (26 degrees C), is generally considered to be a comfortable thermostat setting for air conditioning. If you set your thermostat cooler than this each degree will cost you an extra five percent on your cooling bill.

Use humidity to make these recommended settings seem more comfortable if they are a bit too cool or too warm for you. Humidity makes air seem warmer than it really is. Add humidity in winter, take it away in summer.

Things To Do
1. Show and describe the points to consider when buying an appliance.
2. Describe some unusual electrical appliances you may have at home, have seen at a store or in a catalog.
3. Imagine you were an inventor. Tell what electrical appliance you would build. Draw a picture and explain how it would work.
4. Conservation at Home List some of the “permanent measures” and some of the “practices” you can adopt at home to help conserve energy. Your County Extension office or your power supplier may have some literature that will help.
5. “EER” If you have room air-conditioning units at home (“window units”), figure the energy efficiency ratio for each. How does your air conditioning measure up?

IX. Maintaining Home Appliances

As with most items you pay good money for and use regularly, maintenance is important to keep appliances working well and to keep them in service for a long time. We can consider maintenance of such equipment as involving two basic activities: Preventive maintenance and troubleshooting.

Preventive Maintenance
There are certain basic “ounce of prevention” measures that apply generally to all appliances: Keep them clean, store them properly, protect cords from damage and lubricate those with moving parts that are not permanently lubricated.

1. Keep them Clean Dirt is a prime enemy of appliances. Dirt causes moving parts to wear or stick, interferes with the function of heating appliances and is unsanitary.

Appliances with chromium, porcelain or enameled finishes can be kept clean by wiping with a soft cloth. To remove spots, use a little mild soap or detergent and water on your cloth. Then use a dry cloth to polish.

Check the instructions on small cooking appliances to see if they can be immersed in water to clean.

For safety's sake, always disconnect the cord of a small appliance from the wall outlet before starting to clean it.

Be careful not to damage the heating element when cleaning a toaster or other heating appliance.

Some manufacturers suggest using fine steel wool soap pads to remove cooked-on food (except on chromium or enamel), but avoid scraping a metal surface with a metal scraper or using coarse scouring powders. These can scratch and dull the finish. Pretreated surfaces such as a waffle maker need only wiping with a damp cloth.

The interior of a frying pan or similar appliance can be cleaned with a fine steel wool or plastic soap pad, unless the manufacturer’s directions say abrasives should not be used. Some finishes which are put on to keep food from sticking, such as “Teflon,” are destroyed by scouring.

Pour only hot water into a hot pan. Cold water may cause a hot pan to warp.

Coffee makers made of metal other than aluminum may be made clean and sweet by putting in a tablespoon of baking soda or vinegar and proceeding as though you were making coffee. There are special cleaners for use on aluminum, but you can brighten aluminum by heating in the utensil a solution of two tablespoons of cream of tartar in a quart of water.

It may be necessary to remove a grille or guard on some appliances to clean them thoroughly. It may also be necessary to remove a buildup of dirt or oil with a cloth or brush dipped in a solvent. (Make sure the
appliance has dried thoroughly before using it again). Always be sure to replace guards on grilles properly.

Empty or replace vacuum cleaner dust bags often to keep suction at its best.

2. **Store appliances properly** Large appliances are not usually "stored" because they are kept right where they are used at all times. Small appliances, however, often must be stored because there is no room for them at the point of use. Or, they might be seasonal in use, and would only be in the way at "off" times of the year.

The place of storage for such appliance should never be a barrier to their use, however. You may find that putting up a simple shelf will make a convenient storage place.

Of course, appliances must be kept where they will not be damaged, and where they will be protected from dust and excessive amounts of sunlight.

Plastic or fabric covers can be bought or made for appliances such as toasters, mixers, washers, dryers, etc.

3. **Protect Cords from Damage** Many appliance troubles result from failure of the cord. The many fine strands of wire that make a cord flexible will break if they are flexed too many times, or if they are mistreated in some way. Insulation will break down from exposure to heat and sunlight.

To make your cords last as long as possible, avoid: kinking them, disconnecting them from the wall by pulling on the cord instead of the plug, hanging them over a sharp object, wrapping them around appliances that are still too warm from use or storing them in the sunlight.

A good way to store cords is to coil them loosely around the appliance (once it has cooled, and if it does not have sharp corners). Detachable cords can be wrapped around spools fastened to the inside of a cabinet or pantry door. Or, they can be coiled loosely and put in a convenient drawer.

4. **Oil As Needed** The need for lubricating an appliance is determined by two things: the way it was built and the use it gets.

Appliances with few or no moving parts may need little or no lubrication. The same is true of those appliances that are permanently lubricated at the factory. For a reliable guide, see the instructions that come with the appliance.

If the appliance requires lubricating, use light "household" oil, unless another lubricant is specified. Oil sparingly. Too much oil can damage insulation or rubber parts. It could also drip where it's not wanted, as from a food mixer into the food.

A service chart might be a good idea to add to your appliance file. The chart could show what care should be given to your appliances and how often it should be done.

Leave plenty of room on your chart to write in the date that, say, the motor was oiled, the filter was cleaned, etc. Then at a glance, the chart will tell you when to do the job again. You can post your chart on the inside of a door where you will see it from time to time to remind you to follow up on service.

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Service Needed</th>
<th>How often</th>
<th>Dates done</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable heater</td>
<td>Oil fan motor, clean fan blades and heating element</td>
<td>Once a year</td>
<td>11/60, 10/61</td>
</tr>
</tbody>
</table>

**Troubleshooting**

The need for "troubleshooting" can be evident long before an appliance stops operating altogether. Sometimes appliances exhibit "warning signals" to tell you they are in need of attention. More than just annoyances, they represent real dangers which only the foolish will ignore. Some of these general "warning signals" are:

1. Blinking or annoying "on-off" periods in the operation of an appliance usually mean there is a loose connection. Perhaps it's only a loose screw, but tighten it before a more serious problem occurs.
2. A tingle or slight shock when handling an appliance or switch tells you there's a short circuit. Inspect for loose wires or poor insulation. The appliance may need a "ground wire" connected.
3. Crumpling or cracking insulation will eventually expose wires which can cause a short or shock. Repair or replace with new heavy-duty cords (as shown in the first section on "Working with Electricity," Unit 3 of the program).
4. The most obvious warning signal, of course, is when the appliance fails to operate at all when turned on. First check for a blown fuse or tripped breaker on the circuit the appliance is connected to. If this isn't the problem, test the plug and cord using a test lamp. If the test lamp does not burn, the cord or plug needs to be repaired. If these prove to be all right, there is likely something wrong with the motor, switch or heating element. Return the appliance to your dealer, serviceman or manufacturer for repair, or discard it.
5. Overheating motors in motor-driven appliances may be a sign that the motor bearings need to be oiled or that the motor is overloaded. If the motor on a vacuum cleaner runs hot, empty and clean the bag. Motors on mixers can become too hot when used in too stiff a batter. Motors in constant use should be expected to become hot enough to be uncomfortable to the touch, but they should not smoke!

6. Motors that run too slowly on motorized appliances are a sign of overloading or low voltage. Do not plug more than one appliance into a wall outlet, or use extension cords that result in too long a run of small wire. If overheating occurs, reduce the load.

In addition to these general tips, there are some simple troubleshooting steps you can take to correct common problems that crop up in some of the appliances you use the most.

1. **Heating Elements.** Heating coils on small appliances are of two types, totally enclosed coils which cannot be repaired at home and open type coils to which temporary repairs can sometimes be made. Reattach a broken coil to its terminal (if the break is close to the terminal) by cleaning the heating element wire at least one-half inch from the end with sandpaper or a knife, then fasten the wire around the terminal in the direction the screw or nut tightens.

2. **Fry Pans, Waffle Irons and Roasters.** When cooking appliance such as these will not heat, check for the following possible problem:
   a. The thermostat may be set on the “off” position or operating improperly.
   b. The fuse is blown.
   c. The cord or plug is broken or has a loose connection.
   d. In the case of the waffle iron, the connecting cord between the upper and lower elements may be broken. Disassemble and repair as you would any other cord.

**Things To Do**

1. **A “Caddy” for Cleaning Equipment**
   You may want to consider building a cart with casters and a handle, in which you can store your cleaning equipment and which can be moved around the house as needed.

   Use ¼-inch plywood, four casters, a handle and nails or screws. Make the dimensions suitable to handle your equipment.

   ![Diagram of a caddy for cleaning equipment]

2. **Comparing Appliances**
   Obtain as many makes of a particular appliance (toaster, mixer, etc.) as you can. Perhaps a neighbor or appliance dealer can help, but be sure to take very good care of any borrowed equipment. Using the features comparison chart form as suggested in the section, show on the blackboard the advantages of each. Make clear that each buyer should select the model of appliance that best suits his or her needs.

   Show an early model of some appliance such as a toaster and compare it to a new model using the same chart.

3. **Storage of appliances.** Is everyone in your home happy with the storage of your appliances? Are some stored in inconvenient places? See if you can devise more convenient storage for your appliances, especially those used most frequently.
X. How Much Do You Use?

Electricity is a valuable resource! For that reason, it must be measured carefully as it is used, so everyone pays his “fair share” for the energy he uses. Measuring energy also can help us keep tabs on our energy use habits so we will know when and where to conserve. In this unit we will discuss how to figure out how much electricity is being used and how much it costs to operate. See Unit 5 for a discussion on how to read your meter.

What are some of the ways in which electrical energy is measured?

Watts, Kilowatts, Horsepower & KWH

We should be quite familiar by now with the term “watts.”

We know that it is a measure of electric power, and that it represents the necessary combination of “amps” (electric current) and “volts” working together. Neither amps nor volts by themselves give you any electric power.

For example, you can have 230 volts of electrical pressure available, but if there are no free electrons to flow (and thus no current), there can be no power. Or, you can have enough free electrons in a circuit to provide a flow of, say, 70 amperes, but without voltage to make them flow, there can still be no power. However, if you combine 230 volts and 70 amperes, you have enough power to heat a home or run a large electric motor.

We have seen that to arrive at the unit of measurement which shows what volts and amperes together can amount to in terms of power, you simply multiply the two together to get the term “watt,” or:

\[ \text{Volts} \times \text{amperes} = \text{watts} \]

\[ (\text{Pressure}) \times (\text{Current flow}) = (\text{Power}) \]

Our example above would give us 230 volts times 70 amps equals 16,100 watts of power.

We also know that most appliances, light bulbs, etc., are rated in watts, with this rating information printed on them or on nameplates attached to them.

Often, when we are referring to a large number of watts (such as in our example above), we use the term “kilowatt.” This simply takes advantage of a Greek word “kilo,” which means 1,000. Thus a kilowatt is 1,000 watts. 16,000 watts becomes 16.0 kilowatts.

Another energy measurement term you have probably heard is “horsepower.” Most items of electrical equipment are measured in watts, but most motors are measured in “horsepower.”

Horsepower (hp) as a measure of energy has been around for some time. It is a measure of the rate at which work is done. To give you some idea of how much work is involved in one horsepower, consider that if you bent down and picked up a 100-pound bag of flour and lifted it quickly and smoothly up to head height in one second, you would have done work at the rate of one horsepower! You couldn’t keep that up for long!

Horsepower is easily related to watts. Theoretically, one horsepower is 746 watts. This does not apply to motors, though, because it does not take into account the losses of energy due to heat and friction.

Therefore, you can figure 1,000 watts for each horsepower if the motor is ½ horsepower or larger. For motors of less than ½ horsepower, figure 1,200 watts per horsepower. Thus, a 5 hp motor will use 5,000 watts at full load; a ¼ hp motor will use about 300 watts if it is pulling a full load.

Now we have the terms watts, kilowatts, and horsepower in mind as measures of electrical power. All of these terms are measures of the rate of doing work. They can also be considered as measures of power, or ability to do work. The higher the wattage or horsepower rating, the more work the device can do.

But the really important measurement of electrical energy is not its ability to do work, but the amount of work it actually does. We must therefore have some measure of the amount of work done — the amount of energy consumed. Watts and horsepower do not give a measure of the total amount of energy that a piece of electrical equipment actually uses. You need still another unit of measure that takes into account the time the equipment is in use.

We simply multiply the ability of the appliance to do work — measured in watts times the number of hours worked. The result is a “watt-hour,” a measure of electrical work (not power) or energy delivered. A
watt is one watt of electrical power used for one hour. If you use an electric mixer with a 100-watt motor full speed for one hour, you have used 100-watt-hours of electrical work — or energy. We usually express electrical work done in "kilowatt-hours" (1000, watts per-hour) — often abbreviated "kwh".

You will use one kilowatt-hour of electrical energy if you use:

- A 100-watt light bulb for 10 hours (100 watts x 10 hours = 1000-watt-hours = 1 kwh).
- A 1500-watt electric dryer for 40 minutes (1500 watts x 3/4 hour (40 minutes) = 1000 watts-hours = 1 kwh).
- A 20,000-watt central heating unit for 3 minutes (20,000 watts x 1/20 hour (3 minutes) = 1000 watt-hours = 1 kwh).

Watts are thus a rate of doing work, while a kilowatt-hour is the amount of electricity used.

How much Does it Cost to Operate

This is a question often asked, especially when a new piece of equipment is being purchased. It is an important question — one you can usually answer for yourself just by understanding how electrical energy is measured.

Many people are confused by the measurement of electrical energy. After all, it is customary to buy goods by measure (gallons or quarts) or by weight (pounds or tons). Electrical energy, of course, can't be measured this way.

Electrical energy, as we have learned, must be measured in "kilowatt-hours" — or kwh.

Electric companies send you a bill, usually once a month, according to how many kilowatt-hours of electrical energy you have used during the month.

Estimating Operating Costs

By knowing how much energy an appliance uses, you can see how much it contributes toward the total amount of energy used in your home in a month's time — and thus how much it costs to operate the appliance.

To do this, you will need to know the wattage of the appliance and the number of hours it is in use each month. To estimate its operating cost, follow the steps:

1. Figure the wattage of the appliance. This is usually printed on the nameplate. If not, and the amperage is given, multiply this by the circuit voltage to get the watts.
2. Estimate the number of hours the appliance is used in a month.
3. Multiply the watts by hours of use, and divide this number by 1000 to get the kilowatt-hours of energy used.

\[ \text{kwh} = \frac{\text{watts} \times \text{hours}}{1000} \]

4. Look at a recent electric bill. It will show the total number of kilowatt-hours you have used in a month's time, and of course the total amount of the bill. Dividing these two will give you the average cost per kilowatt-hour.

For example, let's say last month's bill was for 600 kilowatt-hours and cost $30. The average cost per kilowatt-hour would be:

\[ \frac{\$30}{600} = \$0.05 \text{ or } 5\text{¢ per kwh} \]

5. Multiply this average cost by the number of kwh that you estimated used by the appliance.

For example, a 200-watt light bulb used an average of 4 hours a night for a month, will use 200 x 4 x 30 = 24,000 watt-hours in one month, or 24 kilowatt-hours. The monthly usage cost, based on the example electric bill, would be 24 kwh x 5¢ per kwh = $1.20.

This method of estimating usage cost can be a big help when deciding whether to buy a new appliance to do a job currently done by hand or to replace an older model.