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Lighting and Sound

Lighting can be used to divide the stage and to give depth to the space, as in this set from *Beehive*.



With the light I state my vision, my version of the universe.

—JENNIFER TIPTON, TONY AWARD-WINNING LIGHTING DESIGNER

SETTING THE SCENE

Focus Questions

How does lighting affect a play?

What basic equipment should be available for a performance?

How are lighting plans and cue sheets prepared?

What is basic sound equipment for the theater?

How are sound effects made?

Vocabulary

spotlight	floodlight	backlight	tweeters
dimmer	Fresnel	scrim	midrange
light panel	portable striplight	light plot	woofers
cable	roundels	lighting cue sheet	feedback
connector	gelatin	acoustics	intercom systems
ellipsoidal reflector spotlight	key light	microphone	sound-effects board
follow spot	fill light	amplifier	sound plot
	sidelight	speakers	sound cue sheet

*S*tage technology, including lighting and sound, is a rapidly expanding phase of the theater arts. Lighting is taking the place of paint in many productions because it instantly transforms backgrounds, indicating changes in mood, action, and location. Sound effects, in addition to music played between scenes, also affect mood, action, and location.

Designing effective and imaginative lighting and sound can be intriguing and challenging, whether you are working with the simplest or the most sophisticated equipment.

Stage Lighting Effects

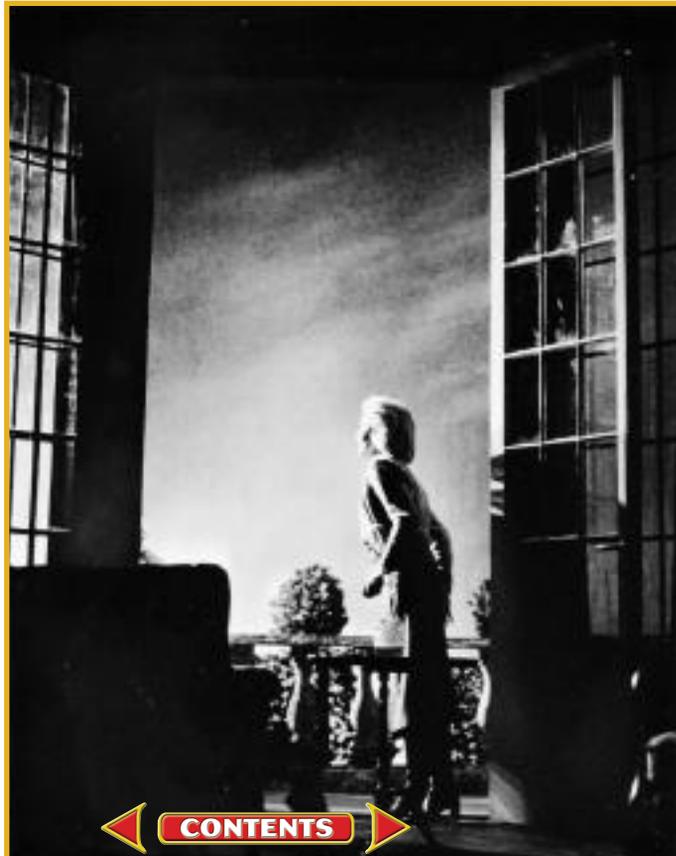
*F*ROM THE PROS

"To me, lighting is the audience's guide to the story, and to what the production is doing. Light can confuse or clarify the issue."

—JENNIFER TIPTON,
TONY AWARD-WIN-
NING LIGHTING
DESIGNER

Imagine that as the curtain opens we look in on an antiquated English manor house. The room is dark except for a flickering glow from the fireplace. A dim figure appears in the archway, silhouetted against the diffused light of the entrance hall. The room instantly comes to life as the young woman presses the wall switch and the chandelier and the two sconces over the fireplace illuminate the right half of the stage. She presses another switch, and the lamp by the chair at stage left brightens the rest of the room. The actor swiftly crosses upstage to the high window and pulls the drapery cord. Immediately the stage is flooded by bright sunlight reflected off the snow-covered terrain outside. She crosses down right to the fireplace and places two more logs on the dying fire. As she stirs the coals, a reddish glow warms her face. She turns, takes two steps toward the table, center, looks at her watch and utters the first line of the play: "I *do* wish Martin would hurry. It's been nearly three hours since he called."

Dramatic backlighting creates a mysterious atmosphere in this scene from the Agatha Christie melodrama *The Unexpected Guest*.



The audience probably did not notice that after the initial flash broke the darkness, the room continued to brighten. It is unlikely, too, that they noticed the “sunlight” dimming slightly after the first rays struck the actor’s face. Nor would we expect the viewers to question whether the fire glowed as brightly after she turned toward the middle of the room to deliver her first line. Certainly, the audience never wondered what lighting equipment was used for that effect. Audiences accept the illusions created by modern stage lighting.

For hundreds of years, plays were performed almost exclusively in the daytime out of doors or in buildings open to the sky. The use of many candles and torches eventually made it possible to present plays in a completely enclosed structure. It was not until gaslight replaced candles in 1803, however, that artificial light aroused much interest. By the 1820s, Thomas Drummond, of England, had developed one of the earliest spotlights, an oxyhydrogen flame directed against a block of calcium oxide, or lime. Actors soon learned how to play in the “limelight.”

With the greater use of artificial lighting, however, came the increased danger of fire. The history of theater has been blackened by the ashen shells of once-active playhouses. By the end of the nineteenth century, electricity had revolutionized home and theater lighting. Today we present well-lighted plays with the aid of modern computerized equipment.

All students of drama—actors, directors, and crew—should understand the basic principles of light, its peculiarities, qualities, and effects on actors, audiences, costumes, makeup, and pigments.

Lighting Equipment

The ideal lighting equipment for the school stage is flexible, efficient, and economical. Of these, flexibility is the most important consideration. Flexibility is determined by (1) mobility: how easily you can move an instrument about the auditorium according to the needs of various productions; (2) control: how easily you can control the amount of light, usually by a dimmer panel; and (3) multiple service: how many different areas you can light with the instrument.

When determining the lighting equipment needed, you must consider the availability and number of **dimmers**, the size of the stage (especially the depth of the acting area and of the apron), the height of the theater ceiling or the distance to the balcony rail, the availability of mounting locations, and, of course, the budget. Every high school, however, should try to have the minimum equipment described in the chart on the following page.

CUE

The versatile **spotlight** meets flexibility needs most effectively. It is mobile and easy to control; it also provides multiple services and the best control of light distribution.

Common Equipment

Light Panel



a console from which the brightness of light is controlled

- The operator can choose which dimmer on this console will control the brightness of the light of any given instrument.
- The most common type has plugs connected to each outlet or instrument in the auditorium. These can be inserted into a “patchboard.”
- A modern option is a computerized solid state relay system (SCR) with memory and monitor. Set-ups with one dimmer per circuit are also available. These electronic consoles cannot be overloaded because the electrical load does not pass through the console. Schools purchasing an SCR should always obtain one that allows for manual control as well as program capabilities.

Cable

heavily insulated wire for joining instruments to electrical outlets or to a switchboard

Connector



device for joining cables to each other or for joining cables to instruments

- Stage cables and conductors are essential to the safe conduction of electricity. The danger of overloads, shorts, and fires is still great on most high school stages. It is easy to be careless about completing an electrical circuit safely.

Common Equipment

Ellipsoidal Reflector Spotlight



a highly efficient light with an ellipsoid-shaped reflector; used in pairs

- For front lighting, one pair of 500 to 1,000 watts each is needed for every eight to ten feet of proscenium opening.
- For washes, sidelighting, and backlighting, ten to twelve more are required.
- These spots are often mounted in the ceiling, on balcony rails, or on electric battens.

Follow Spot



a long-range, high-wattage light capable of following an actor's movements on stage; essential for every stage

Floodlight



a high-wattage light, open at one end, containing a metal shell and a highly reflective inner surface

- Floodlights are used for special effects such as sunlight and moonlight.
- A minimum of four is needed; additional ones are required to light cycloramas.

Fresnel



a spotlight with a stepped lens, used to project a clear, strong light with a soft edge

- At least fourteen 500-watt instruments are needed.
- They are mounted on a pipe just behind the grand drape and on pipes located one-third to two-thirds upstage.

Striplights and Portable Striplights



lamps arranged in metal troughs, usually with three or four circuits; sometimes called borderlights when hung from pipe battens above the stage

- Three to four of each are required for general stage use and scenic color blending.
- They are used for side lighting, backing or entrance lighting, or cyclorama lighting.

Other desirable equipment includes the following:

- ellipsoidal reflectors for mounting on side walls of the auditorium
- additional Fresnels for the first batten
- one or two automated lighting fixtures
- a second follow spot
- blacklight units and special-effects projector
- pipe clamps for hanging instruments
- color frames for each spotlight and floodlight

In addition, it is desirable to have some color media, such as **roundels** for striplights or **gelatin** for the spots and floods. The best colors for the color media in the striplights are red, blue, and yellow because a combination of these three colors will make all the colors in the spectrum. Amber is sometimes substituted for the yellow; this choice is wise only if the light panel is one of toggle switches rather than dimmers or if a stronger overhead light is desired.

You will find that new types of lighting equipment are constantly appearing. The tungsten-halogen lamps provide much more efficient light at far less cost than incandescent bulbs. Many T-H bulbs will last four times as long as conventional bulbs. The T-H bulbs run very hot and require gels that will not fade quickly or warp from the heat. The T-H lamp will crack or bulge if exposed to perspiration from fingers. Therefore, the lamps must be carefully installed with the protective covers in place. If the lamp is later removed, it should be cleaned with isopropyl alcohol.

Application ACTIVITY

Suppose that you are in charge of purchasing lighting equipment for a new theater at your school. Obtain catalogs from lighting companies. Create the following three purchase lists: one for a school that can purchase only the minimum equipment, a second for a school with more resources, and the third for a school with unlimited resources. (*Resources*, in this case, refers to money, a theater facility, people, and time.)

Basic Lighting Principles

Without a doubt, lighting is the most important element in scenic design because it affects the creation of mood and atmosphere. The exuberant nature of a musical is enhanced by the cheerfulness of a brightly illuminated stage. A mystery takes on a spine-tingling quality when the high walls and deep recesses of a deserted mansion are lost in the depths of shadows. An eerie fog, an iridescent liquid in a witch's cauldron, the ghostly whiteness of a full moon, the aura of intrigue and death in the shadowy alleys of counterespionage—you can create each of these on stage by the right choice of color, gobos, and proper distribution and brightness of light from carefully selected instruments. Effective stage lighting is based on three qualities of light: intensity, or brightness; color; and distribution, or area covered.

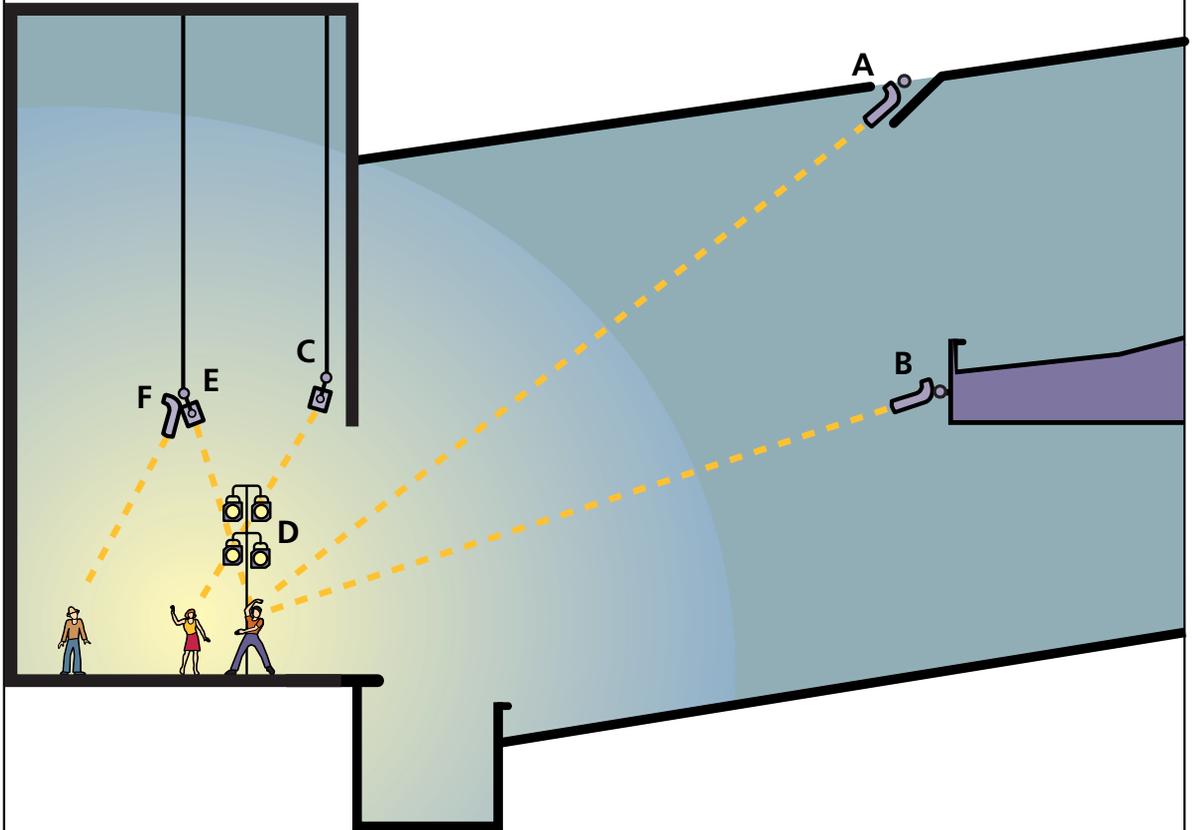
INTENSITY

The lighting designer should never allow actors to be lost in unintentional pockets of dark shadows. Nor should the lighting designer try to eliminate all shadows with generalized bright light. This results in one huge flat glow of light, which is the most common lighting error on the high school stage. This problem stems from the incorrect notion that lighting a set means turning all available instruments on full. This garish amber-white light makes actors “dead” on the stage or makes them disappear into the set. Many of the most successful designers today use only spotlights and floods. Others add borders and foots for blending only. In any case, strong lights should be kept off the walls of a set. Most designers suggest keeping the upper walls in shadow.

Intense lighting can be used to emphasize certain aspects of a scene. This character in *The Crucifer of Blood*, a Sherlock Holmes mystery, is unobtrusively lit from the front, but the overall effect of the lighting is to make the audience think the scene is illuminated by only the “moonlight” streaming in through the latticed windows.



LOCATION OF LIGHTING



- A = Key and fill first depth
- B = Wash
- C = Key and fill second depth
- D = Sidelighting
- E = Backlighting
- F = Key and fill third depth

Diagram of a general lighting plan for downstage areas

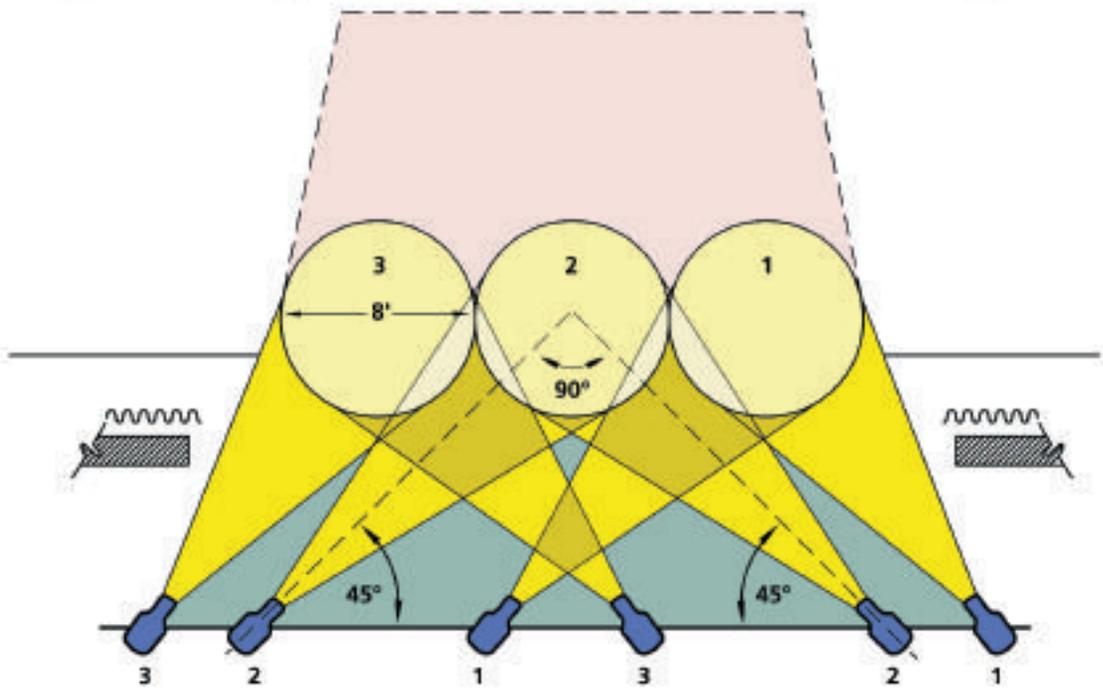
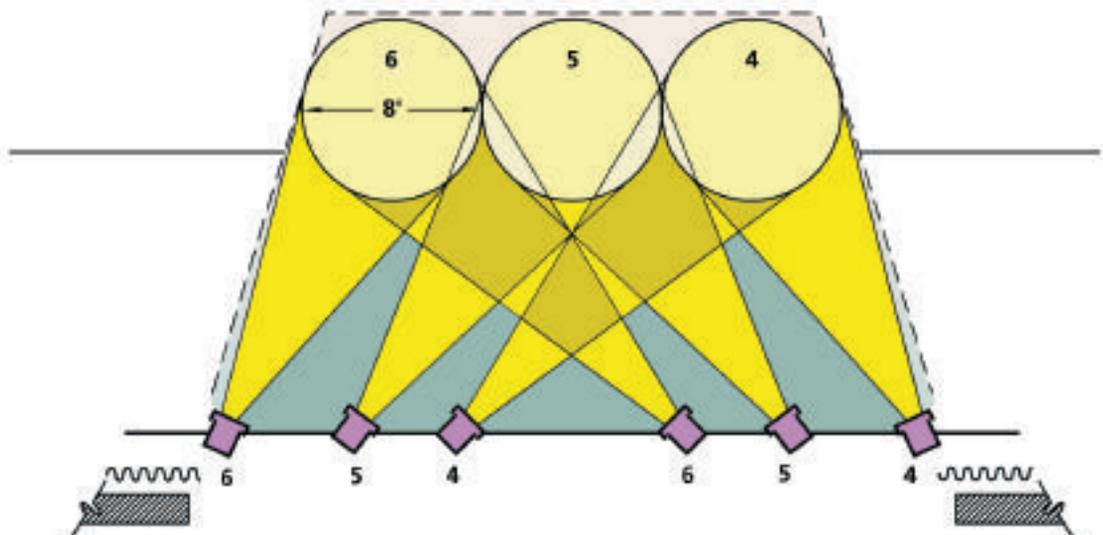


Diagram of a general lighting plan for upstage areas



FROM THE PROS

"If you can imagine the two-hour show as a canvas, you then work with very broad strokes to rough out the pace and the direction of the show in a way that allows you to build on it and give it different plateaus, and, finally, a really good ending."

—PATRICK WOODROFFE,
LIGHTING DESIGNER
FOR THE ROLLING
STONES' VOODOO
LOUNGE TOUR, 1994

Sharply contrasting colored lights give this scene from *Blood Wedding* a high level of energy. The blue light conveys serenity, while the red light conveys power and movement.



Most lighting changes should happen gradually by **dimming up** or **dimming down**. Lights rarely pop on or off except when a light switch is flipped onstage. Even then, not all instruments come on at once. Within a scene, lights normally change with a **crossfade**: some lights come up at the same time others dim down. The audience should not consciously notice that a change is taking place. Technicians must therefore begin light changes far in advance in order to accomplish them smoothly.

There are some general considerations to remember when working with stage lights. Brightly lighted scenes, especially of the type frequently found in musical plays, can cause changes in the appearance of makeup and costumes. Strong amber can turn colorful fabrics into a drab brown; too much red may wash the rouge out of the actors' faces.

Night scenes are always difficult to light without having costumes and makeup turn black under a green-blue light. Therefore, the colors used in most night scenes will make rouge and lipstick look grotesque. When scenes are to be played in the dark, it is always best to have some light even if no attempt is made to represent natural light sources. An unlighted stage is dead. Figures outlined against a moonlit window, a shaft of light through a window or skylight, a crack of light from under a door,

or the glow of an old-fashioned streetlight can provide a realistic source for the stage light. However, if no other choice is left, a beam or two of colored light that is there solely for the reason that the actors must be seen will meet the requirements for light. The audience should never be left completely in the dark for more than a few seconds.

COLOR

The effect of light on color is difficult to predict accurately because of the relationship between light, pigments, and dyes. Some generalizations, however, can be made:

red light on red	= red
red light on blue	= violet
red light on green	= gray
red light on yellow	= orange
red light on purple	= red
blue light on red	= violet-black
blue light on blue	= blue
blue light on green	= blue-green
blue light on yellow	= green
blue light on orange	= brown
amber light on red	= brown
amber light on blue	= greenish-orange
amber light on green	= greenish-orange
amber light on violet	= red
green light on red	= black
green light on green	= green
yellow light on blue	= blue-green
yellow light on green	= green
yellow light on violet	= brown

The only way to produce green light is by using green color media. The delicate colors are the most preferred gelatins in use today. No-color pink, flesh pink, straws, and ambers—especially bastard amber, a light scarlet—are some of the warm colors used. And special lavender, surprise pink, no-color blue, and medium and day-light blue are some of the best cool color gelatins. Sometimes designers use frost and chocolate for special effects. Green-blue makes a better night scene than blues or violets. Many lighting designers prefer white light from an ungelled instrument as a cool light source.

Curtains, costumes, and furnishings are affected by light. Smooth, shiny fabrics reveal light and shadows. Heavy, coarse materials, no matter how inexpensive, absorb much light and often appear quite expensive to the audience; outing flannel can look like expensive velour. The important consideration is the brilliance of the color of the material and the color of the stage lighting for the scene in which the material is to be used. Patterns and prints cause many problems, as do several colors in the same costume. Lighting period plays is always difficult, for the mixture of lace, silk, velvet, wigs, and makeup is a lighting technician's nightmare.

CUE

As a general rule, tragedies and serious dramas emphasize cool colors, whereas comedies stress warm colors.

DISTRIBUTION

The most effective lighting considers the natural light sources on the set—the sun or moon, a streetlight, lamps, fireplaces, televisions, candles, or lanterns. To avoid a pasteboard-figure effect, designers usually pair spotlights. One uses warm colors and comes from the same side of the stage as the sources of natural light. The other comes from the opposite direction, the direction of diffused or reflected light, and uses cool colors. Each spotlight is aimed in and down at a forty-five-degree angle toward the area to be lighted (see illustration on page 454). This results in the most dramatic effect of highlight and shadow. Designers usually avoid straight-on lighting from centrally located instruments because it serves as a general wash. (A **wash** eliminates shadows and brings a strength of light to the central acting area.) Instead, spotlights used for the wash are best located on the balcony or on the sides of the auditorium and aimed diagonally across the stage.

The most important acting areas need the most light. Bringing a greater quantity of light into a given acting area makes the actor playing in that area stand out. In any lighting plan there is always **key light**, the strongest light aimed at each acting area, and **fill light**, light that fills in the shadows. **Sidelighting** from upstage of the tormentor, using a different color from the front lighting, can help model actors' features and accent costumes. It also adds a touch of life to the production. **Backlighting** comes from above and behind the actor, setting the performer off from the background. The lighting designer may help shift the focus of attention back and forth with the smooth flow of light from one actor or area to another throughout the play.

For this scene from *Les Liaisons Dangereuses*, key light emphasizes the character, while fill light points up the chaise longue behind him.



Application ACTIVITY

Assemble a variety of fabrics of different colors and textures. Then using a series of colored lights, observe the effect of the various colored lights on the fabrics. Share your findings.

Special Lighting Effects

Lighting is probably the designer's most versatile source of special effects, accomplishing such feats as pinpointing a face in a crowd, changing the stage into a blazing inferno, suspending animation, or creating the illusion of a silent movie by the use of a flicker wheel or strobe.

Using a **scrim**, or gauze drop, creates some of the most striking scenic-lighting combinations. Lighting a scrim from the front makes it nearly opaque, and lighting it from behind makes it semitransparent. Scrim, properly lighted, help create fog, mist, and dream scenes. Actors and cut-out scenery may be silhouetted against the scrim by backlighting.



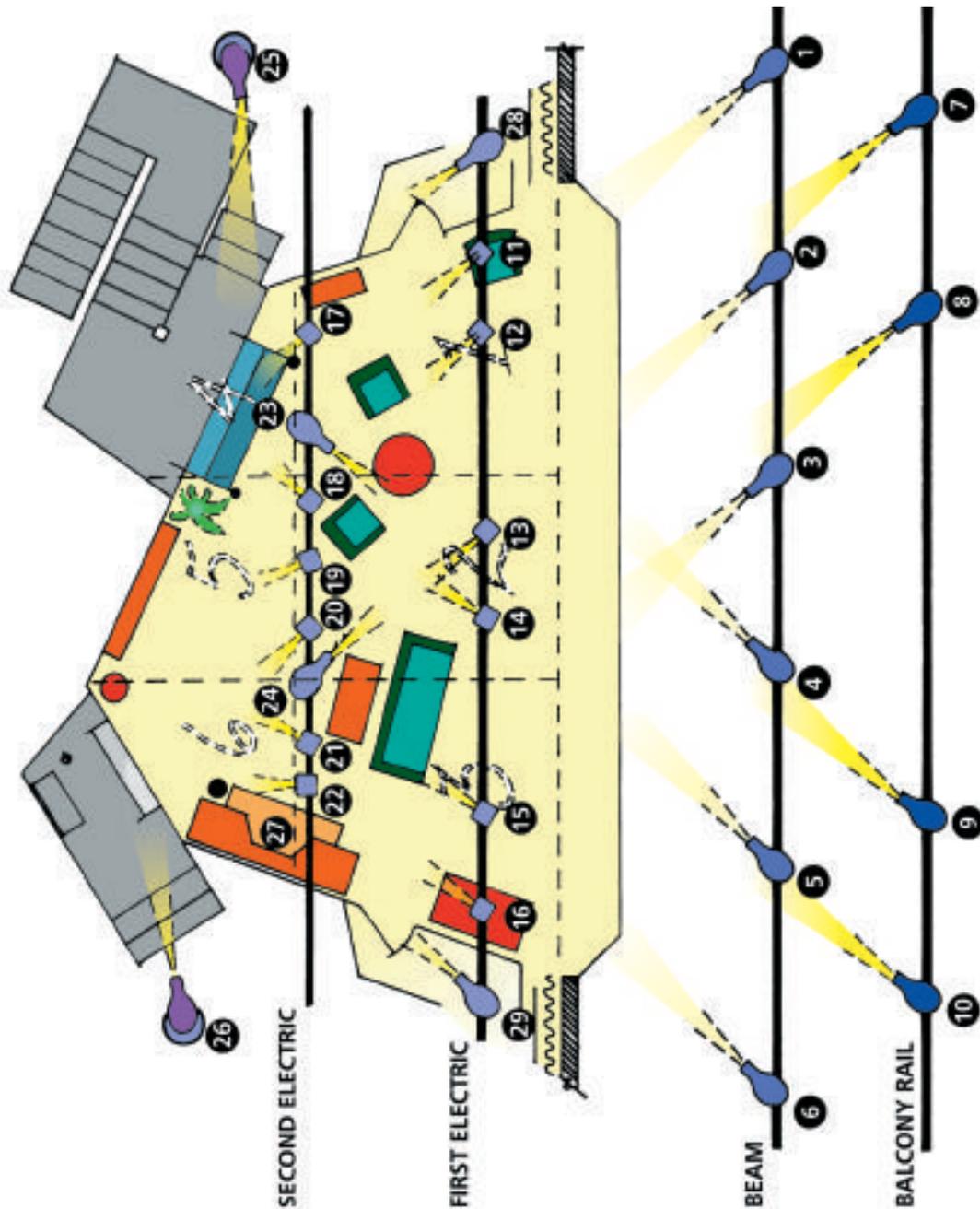
The setting for this scene from the Sherlock Holmes mystery *The Crucifer of Blood* is the River Thames in London. A smoke machine and overhead lighting produce the illusion of the dense fog that often covers the Thames late at night. The lighting also isolates the characters against the dark background.

LIGHTING PLAN FOR <i>ONCE IN A LIFETIME</i>							
FUNCTION	INSTRUMENT NUMBER	INSTRUMENT TYPE	LOCATION	LOAD WATTS	COLOR	DIMMER WATTS	NOTES
AREA 1 KEY	1	8" ELLIPSOIDAL	BEAM- L	750	34		FRAME OFF RETURN
AREA 2 KEY	2	" "	BEAM- L	750	34		
AREA 3 KEY	3	" "	BEAM- L	750	34		
AREA 1 FILL	4	" "	BEAM- R	750	54		
AREA 2 FILL	5	" "	BEAM- R	750	54		
AREA 3 FILL	6	" "	BEAM- R	750	54		FRAME OFF RETURN
L. CENTER WASH	7	" "	BALCONY R	1000	33		
R. CENTER WASH	8	" "	BALCONY R	1000	33		
L. CENTER WASH	9	" "	BALCONY L	1000	60		
R. CENTER WASH	10	" "	BALCONY L	1000	60		
AREA 4 KEY	11	6" FRESNEL	1 ST ELEC L	500	33		
AREA 5 KEY	12	" "	1 ST ELEC L	500	33		
AREA 6 KEY	13	" "	1 ST ELEC LC	500	33		
AREA 4 FILL	14	" "	1 ST ELEC RR	500	54		FRAME TO ENTRANCE
AREA 5 FILL	15	" "	1 ST ELEC R	500	54		
AREA 6 FILL	16	" "	1 ST ELEC R	500	54		
STAIRCASE & LANDING	17	" "	2 ND ELEC L	500	34		
STAIRCASE & LANDING	18	" "	2 ND ELEC LC	500	54		
BOOKCASE AREA 5	19	" "	2 ND ELEC C	500	34		FRAME OFF WALL
FOYER LANDING	20	" "	2 ND ELEC RC	500	34		
BOOKCASE	21	" "	2 ND ELEC R	500	54		FRAME OFF WALL
FOYER LANDING	22	" "	2 ND ELEC R	500	54		
LEFT BACKLIGHT	23	6" ELLIPSOIDAL	2 ND ELEC LC	500	33		
RIGHT BACKLIGHT	24	" "	2 ND ELEC RC	500	33		
STAIRCASE SPECIAL	25	" "	BOOM UL	500	08		AT TOP OF BOOM
FOYER SPECIAL	26	" "	BOOM UR	500	08		AT TOP OF BOOM
FIREPLACE SPECIAL	27	ROLL LOG	FIREPLACE	200	14		
SL. EXIT SPECIAL	28	6" ELLIPSOIDAL	1 ST ELEC L	500	12		
SR. EXIT SPECIAL	29	" "	1 ST ELEC R	500	06		

Painting or dyeing a scrim makes an impressive traverse curtain, which provides a fine background for short scenes, especially in musical plays. Such a painted scrim can also create the illusion of "passing through." In *The Music Man*, for example, a scrim could be painted to represent the outside of the Madison Public Library. With front lighting, the scrim looks like any ordinary drop, but when the lights come up in the library (behind the scrim), the watchers feel as if they have passed directly through the library's walls.

LIGHTING PLOT

ONCE IN A LIFETIME



What is normally considered a negative effect of light can create one of the more unusual lighting effects. Makeup using colors that wash out under normal stage light is applied over standard makeup. Makeup the same color as the lights has a tendency to disappear. By changing the dominant lighting colors or by having the character move into the beam of a special spot, the actor may suddenly assume the mask of death, the features of an angel, or the ugliness of a Mr. Hyde as the “invisible” makeup is seen.

Few techniques match the possibilities for unique special effects that can be attained by using black light. Many new colors of luminous paint, paper, and fabrics have been developed that increase the flexibility of black light.

Lighting is used to simulate theater marquees in this scene from *42nd Street*. Notice that the marquees vary in size and that the bulbs making up the show titles vary in size and distance from one another. These effects, along with the staggered rows of performers, give the scene depth.



Planning the Lighting

As soon as the director and crew have worked out the needs for costumes, makeup, scenery, and furnishings, it is time to begin work on the lighting. Using the information provided by the director and the scenic designer, the lighting technician must create the light plot and the lighting cue sheet. The **light plot** shows the location of each lighting instrument and the area or object each illuminates. Almost all important acting areas need paired spotlights. However, some locations, such as doorways and windows, can be adequately lighted by one spotlight.

Once the light plot is prepared, the lighting technician can work out the cue sheet. The light plot indicates how the light board is to be set up for each scene. The **cue sheet** shows what changes are to take place: which controls, which instruments, what setting to use, and the length of time each change will take. These are listed chronologically as they appear in the play, including warning cues, execution cues, and timing cues (how to count the time during a change). The matter of timing is of great importance. Electronic systems can be programmed so that they are on timed settings. If the production gets off schedule, the lighting cues will not synchronize with the production and the lighting technician can override the system.

LIGHTING CUE SHEET FOR:							
CUE NO.	PAGE	CONTROL NO.	AREA	START		COMPLETE	
				CUE	RDG.	CUE	RDG.
1	3	M ₁ M ₂ M ₃	1,2,3	FOGHORN	0	BEATSWAIN'S WHISTLE	8
2	3	12,14	6,8	FRANK: "DO YOU THINK..."	0	PHIL: "I DON'T BELIEVE IT"	10
3	5	M ₁ M ₂ M ₃ 12,14	1,2,3 6,8.	SCREAM (KILL)	8 10	(IMMEDIATE BLACKOUT)	0
4	8	M ₁ M ₂ M ₃ M ₄ M ₅	1,2,3 4,5	CAR COMING UP DRIVE	0	CAR STOP	10

Lighting can be preplanned, but since the effects of light on any particular surface or color are unpredictable, the only way to properly light a production is to actually try the costumes, makeup, and scenery under the lights.

All lighting cues need to be worked out in rehearsals, although it saves the time and the patience of the director and cast if most preliminary run-throughs and experimentations can be done in technical rehearsals held separately from cast rehearsals.

The lighting technicians need to see that all equipment is in working order, that cables are not laid where they may be tripped over, and that exposed cables are taped down. Square knots or twist lock connectors should secure each connection, faded gels must be replaced, and any instruments that might have been accidentally moved by actors or crew during scene shifts must be realigned. The lighting crew needs to be alert to the dangers of reflective surfaces—mirrors, highly polished furniture, glass-fronted cabinets, sequins, jewels, or anything else that might throw a blinding light into the eyes of the audience or reveal backstage areas.

All of the action in the play *The Woods* takes place on an outdoor front porch setting. Lighting is used to indicate the time of day that differentiates the scenes.



Three Common Problems in Lighting

Problem	Cause	Solution
The actor “turns on the lights” and the audience waits five seconds before lights change.	The light booth is at floor level or on an elevated platform, stage right so the technician cannot see the actors.	<ul style="list-style-type: none">• Wire onstage lights directly into the power source so they really work, as in a home.• Wire onstage switch to a cue light that technicians can see. This reduces the delay to one that is imperceptible.
All or most stage lights can be only on or off.	Available equipment does not include a dimmer, or dimmers are linked directly to border or footlights only.	<ul style="list-style-type: none">• Invest in a small portable console and do necessary wiring.
Inadequate or no lighting equipment is available.	Budget limitations may be the problem.	<ul style="list-style-type: none">• Purchase small, inexpensive spotlights and floods.• Solicit gifts from parents’ groups, drama club boosters, or other groups.

Application ACTIVITY

Determine what the lighting resources are in the theater used for your school’s productions. Select a scene from a play and prepare a light plot and cue sheet for the scene.

Sound

From theater's beginnings, sound has been a key element in presentation. In fact, the word *audience* is derived from the Latin word *audire*, meaning "to hear." Combined with realistic gestures and expressions, the projection of an actor's voice, including inflections and proper diction, results in artistic expression.

Volume, or loudness, was not an issue when theatrical audiences were small. However, as theater evolved and attendance increased, the need for voice projection and volume also increased. Actors had to pay attention not only to raising the volume of their voices but also to retaining voice quality, for the more loudly an actor speaks, the more he or she must focus on proper diction and projecting inflection.

The structure of theater buildings and auditoriums plays an important part in the projection of sound. A theater's **acoustics**, or qualities that determine the audibility and trueness of the sound of the actors' voices, must be considered when presenting a production.

Sound Equipment

Sound equipment is used in theater for various purposes, including amplification, sound effects, and music. There are several basic pieces of sound equipment, which can be divided into two categories: amplification equipment and recording equipment. Amplification equipment is used to increase the volume of the actors' voices, allowing the entire audience, no matter how large, to hear the onstage dialogue. Recording equipment is used to add music and sound effects.

AMPLIFICATION EQUIPMENT

An amplification system consists of microphones (mikes), amplifiers, and speakers. Cables, cords that deliver the electrical sound impulses from one device to another, connect these. The accuracy of the sound depends in part on the quality of the system but even more on the skill of the sound technician. An amplification system should not be viewed as a tool to improve an actor's voice. Rather, it should be used simply to increase its volume, enabling the audience to hear.

Microphones Electronic amplification of the voice begins with the **microphone**, a device that receives sound waves and changes them into

electronic impulses. There are several types of mikes, each designed for a specific use. The general-purpose microphone, most commonly used for speeches, functions best for backstage lines or announcements in play productions. Usually unidirectional—that is, picking up sounds from only one direction—a general-purpose mike works best when a person speaks into it from a distance of one to two feet.

Another type of microphone, often used by singers, is designed for close-up use (approximately two to ten inches from the mouth). This type of mike is ideal for musical productions. Close-up mikes are often cordless, allowing the user to move freely about the stage. However, if the mike has a cord, the scene must be carefully blocked so that other actors and props do not become entangled in the cord as the user moves about the stage.

In contrast to the close-up mike, the apron mike picks up sound from a distance of ten to fifteen feet. This type of mike is useful for choral numbers in musicals and also for straight plays. With a reception range of forty-five degrees left and right of center (both horizontally and vertically), apron microphones can amplify an entire production. Placed on the apron of the stage, these mikes must be cushioned in a “mouse,” a specially designed foam rubber holder, to avoid picking up stage traffic. For an alternative to a mouse, the technician can place the shaft of the mike on a thin nest of foam with the mike head extended and almost touching the floor. This “nest” can be carved out of the foam that spotlight lamps are usually packed in. A normal-sized stage requires four apron mikes. For strong reception downstage center, place the two center mikes on the floor at a forty-five-degree angle facing each other with the heads nearly touching. Place the other two apron mikes at the sides of the apron. This setup is particularly effective for musical productions because it allows for movement by a soloist or for an equal pick-up of two or more performers in the center-stage area. Actors using an apron mike must stand no closer than three to four feet upstage of the mike. If they are any closer, their voices will not be amplified.

A rifle microphone, also called a shotgun mike or a gun mike, has a long, sensitive range but a narrow pickup pattern. If acoustics are poor and a performer cannot be picked up with other miking, a rifle mike can be the best solution. Placed on the apron down center and down right for soloists, or suspended overhead and aimed upstage at a point of critical action, rifle mikes can fill a critical gap.



A skillful sound technician can greatly affect the mood of a production.

Overhead miking, whether with rifle mikes or with other types of mikes, generally fits a single-set show best. The constant movement of scenery in musical productions means that any overhead mikes must either be continually raised out of the way and then lowered again or be hung so high they are useless.

The microphone most commonly used in professional productions is the radio mike. Sometimes called a lapel mike or a body mike, it can be clipped to an actor's collar, placed in the hair, or hidden in the costume. This mike is powered by a battery pack belted or taped to the actor. Each radio mike requires its own receiver, and a technician must control each mike independently. When radio mikes are being used in a production, every battery pack should be checked before every performance. Also, special attention should be paid to the placement of these microphones; they will amplify the movement or rubbing of costume materials, and if two performers are close to each other, both mikes might pick up one performer and give double amplification. Performers must make a habit of turning off their radio mikes when they leave the stage, to avoid amplifying backstage conversations.

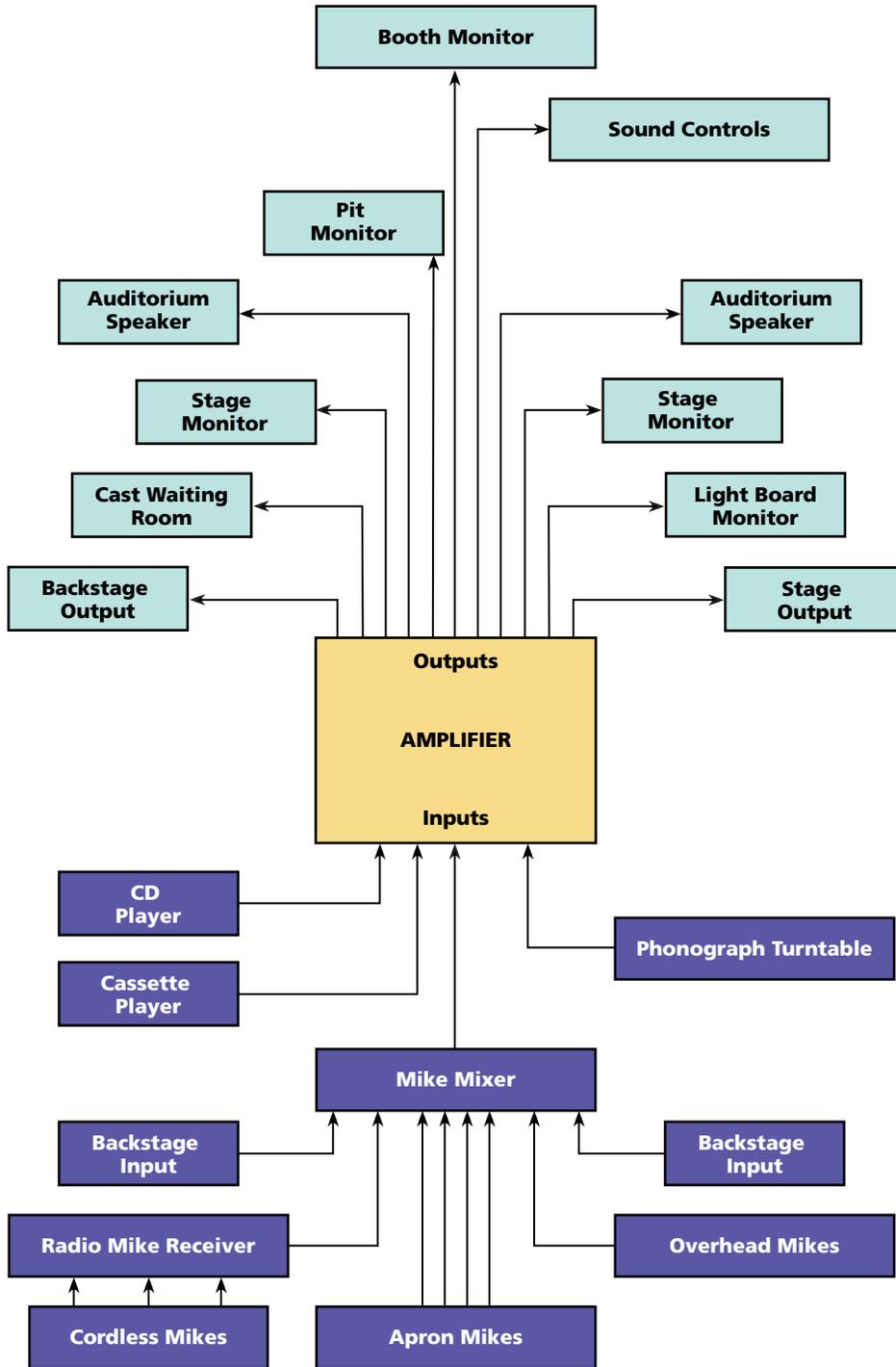
Amplifiers and Mixers An **amplifier** receives a small sound signal from a mike or other source, increases the strength of the signal, and outputs it to a speaker or other destination. To judge the strength of amplification required, the basic formula is one watt per audience member; therefore, most high-school auditoriums need 250 to 1200 watts. A sound specialist can evaluate an auditorium and advise on the necessary equipment.

Ideally, the amplifiers should have at least twelve inputs, or connector receptacles that accept cables from a source, such as a mike. There should be at least eight inputs for mikes, one for each other accessory, and at least one spare input. If the amplifiers do not have enough inputs, a mixer can be added to the system. A mixer can control several mikes individually while it requires only one amplifier input. The amplifiers should also have a sufficient number of outputs leading to the auditorium speakers, to all the monitors—backstage, light and sound technicians, projection booth, pit, greenroom, waiting room—and, for special effects, at least one output located on each side of the stage.

A mixer enables the sound operator to listen to the incoming signal; to adjust each input for volume, tone, and timing; and to send the mixed sound to the speakers. A mixer equipped with foldback lets the mixed sound go to specified speakers placed so the people making the sound can hear themselves with no time delay. Mixers can also supply sound outputs to echo machines, noise gates, samplers, and delay machines to alter the sound further. Today many school productions find that a combination of several mixer-amplifiers meets their needs best.



A Simplified Sound System



CUE

Too much amplification can damage hearing. Adjust volume not only for sound quality but also for safety.

Speakers Cone-shaped devices driven by electromagnets that convert electrical impulses into sound are called **speakers**, which project sound. There are three major types of speaker cones: **tweeters**, which reproduce high-pitched sounds; **midrange**, which reproduce sounds occurring in the middle range; and **woofers**, which reproduce low-pitched sounds. Speaker cones are usually housed in boxes with fabric covering the large end of the cones. Speaker positions must vary with the size and shape of the auditorium, but generally speakers are positioned on both sides of the audience. Often speakers are placed above the stage or even above the audience as well.

Two frequent problems that occur with the projection of sound are ringing and feedback. **Ringing**, which does not originate with the speaker, is a high-pitched sound usually caused by mike volume that is too high. **Feedback** is loud, ear-piercing sound caused by the amplified sound being fed back into the mikes that are picking up the original sound. Dropping a microphone, placing speakers so they face each other, or moving a microphone downstage of the speakers can all result in feedback. Fairly inexpensive solutions to these problems include **antifeedback units** that locate feedback and eliminate it and **compressors** that sense loud sounds and compress them, lowering the volume. However, a sound technician should pay close attention to the placement of the speakers and the volume levels of the mikes. She or he should work closely with the director to avoid stage movements that require actors to move out of areas of proper reception.

Intercom Systems These systems are separate from the general amplification system. Consisting of a base amplifier, headsets, and either battery packs or permanent stations into which the headset connectors can be plugged, **intercom systems** allow communication between the stage manager and members of the stage crew. A two-channel system allows the stage manager to talk to a specific crew member or to the entire crew.

RECORDING EQUIPMENT

Cassette players, reel-to-reel tape players, compact disc players, and turntables allow for the addition of sound effects and pre-show and intermission music. Using cassette or reel-to-reel tape players gives the production staff the opportunity to produce their own sound effects, which can then be played through the general amplification system during the performance.

For more basic sound effects, a sound-effects board, sometimes called a bell board, can be used. A **sound-effects board** consists of several appliances—a doorbell, a door chime, a buzzer, an old-fashioned phone bell, and an electronic phone-tone maker—attached to a piece of plywood. If possible, add a phone ringer, a device that makes a phone ring onstage.



GENERAL SOUND PRINCIPLES

1. The human ear is the best judge of sound quality and volume. If possible, place the sound controls in the auditorium, perhaps centered behind the last row of seats. At least, there should always be someone from the sound crew in the audience checking the sound without a headset (although this crew member may have access to a headset for communications).
2. Each night's show will be unique. At a comedy, for instance, audiences will laugh at different lines from night to night. Performers may alter their positions near microphones and may even alter their delivery. The sound crew must always be ready to adjust to the changes to produce the best possible sound for each show.
3. Professional sound and acoustics experts should equalize the sound system—that is, balance it to the room (auditorium)—and then seal it so the main equalizer cannot be tampered with.
4. Sound levels for mikes, monitors, and accessories must be determined before a performance. Speakers, singers, and actors must arrive early for sound testing. Then everyone can be assured that the equipment is ready; no one will be tempted to tap a mike head (which can damage it badly) or say “Testing, testing” or “Is this thing on?” in the audience's hearing.
5. Sound needs may vary for the same auditorium at different times of the year. Heavy clothing worn by audience members will absorb surprising amounts of sound; in winter, therefore, mikes can be turned up a little. Adjustments may have to be made even after a performance starts if there is considerable coughing in the audience.
6. A microphone should “precede” the user—that is, it should be turned up a bit before the user speaks and then be brought up to its full level as the speaker begins. This technique prevents two common distractions: one is an “explosion” of sound that happens when the mike is turned up to full the moment the speaker begins; the second is the embarrassing “silence with moving lips” that happens when the mike is turned up too late.
7. Caution speakers about “swallowing the mike”—that is, standing too close to it. This can cause plosive sounds (such as *bŭh* and *pŭh*) to “pop” distractingly.
8. SAFETY: Use duct tape to secure all cables in traffic areas.



Sound Effects

Sound effects are essential for most productions. A ringing telephone, a barking dog, and a thunderstorm are examples of sound effects often required in stage productions.

There are two main types of sound effects used for stage productions: live and recorded effects. Live sound effects are sounds made at the time they are heard by using special props. For example, if a telephone is necessary for a production, a real telephone onstage can be wired to the sound-effects board. Because the phone rings on cue and stops ringing when the actor picks it up, real effects like these help to ensure that the timing of the sound effect coincides with the action in the play. In the same way, building real doors and installing real doorbells also add to the believability of a production. If a script calls for a slamming door offstage, but a door is not needed as scenery, miniature (scale) doors can be built to produce the sound effect backstage.

Many live sound effects are made by special machines. For example, a thunder machine uses a large sheet of galvanized iron that hangs from a bar. When struck, the iron sheet rumbles and makes the sound of thunder. In addition to conventional machines, using everyday objects imaginatively provides an inexpensive way to produce sound effects. For example, to make the sound of raindrops falling, drop dry sand or uncooked rice onto a tambourine; crumple a large sheet of cellophane to produce the sound of fire. For a safe and tidy way to make the sound of glass breaking, shake a tightly sealed box of broken glass.

Recorded sound effects are being used more and more in stage productions today. For much of the twentieth century, sound effects were recorded onto vinyl phonograph records and cued for stage productions, but trying to place the needle on the precise groove of the record at the precise moment often led to errors. Fortunately, tape players and, more recently, compact disc players have made recorded sound effects easier to cue. Any sound can be professionally recorded on tape or compact disc for reproduction during a play. Some popular recorded effects include traffic noises, sirens approaching or departing, the audio portion of a television program, and the sounds of natural disasters (for example, earthquakes or tornadoes). Recorded effects are especially successful when used with real props. For example, a radio used as an onstage prop can be wired to backstage sound equipment. When the actor turns the prop on, the recorded radio show sounds as if the prop produced it. For greater authenticity, place the speaker onstage near the prop.

There are many ways to obtain recorded sound effects for a production. Various theater supply companies sell previously recorded sound-

effects tapes and compact discs at a small cost. Sound-effects recordings are also available for specific productions, but always be certain to obtain permission to use prerecorded sound effects that fall under copyright laws. The fee for permission to use these effects is often very low.

It is also possible to record your own sound effects. A synthesizer or a keyboard can produce a variety of interesting sound effects. Many computers are equipped with programs that make, record, and store original sound effects. When making your own sound effects, be sure to record them in the order in which they will be played. If you have a reel-to-reel tape recorder, splice in white or colored leader tape (tape that does not record) between sound effects and label each effect on the leader tape.

Planning Sound

Pre-show music and intermission music add a professional touch to a production. Select the music carefully to match the style and mood of the show. Monitor the volume level carefully because the noise from a talking audience may call for an adjustment of the music level downward for comfort. Unless you have chosen works in the public domain, be sure to obtain permission and pay any fee required to use the music.

A **sound plot** shows the pieces of equipment and their settings for each sound in the show, including music, actors' dialogue, and sound effects. If a show has much live sound or live mixing of music, it is wise to schedule separate sound-plotting sessions to make the technical rehearsal go more smoothly.

A **sound cue sheet** includes each sound effect, its cue number, the script page number, the name of the effect, the volume level, and the length in seconds of the effect. The stage manager should have all sound cues marked in the promptbook and should call all sound cues, including microphone warm-up cues. The stage manager should decide how to alter the sound levels and timing for each performance's specific conditions.

Application ACTIVITY

With a partner, choose a scene, perhaps from "A Treasury of Scenes and Monologues," and plan the sound and sound effects. Design a sound plot and a sound cue sheet. Refer to the lighting plot and lighting cue sheet on pages 461 and 463.

CUE

To produce high-quality sound, set the volume level low on the tape player or record player, and control the volume of the sound on the amplifier.

**Summary
and Key
Ideas**

Summarize the chapter by answering the following questions.

1. Describe several ways in which lighting enhances a performance.
2. Identify the lighting equipment necessary for a musical production in your high school.
3. Describe Fresnels, floodlights, and striplights.
4. What is the most common error in the lighting of high school plays?
5. What information is included in a lighting plan and cue sheet? In a sound cue sheet?
6. Describe the use of four kinds of microphones.

**Discussing
Ideas**

1. If you were lighting a single figure in a simple white costume standing against a white background on a fairly small stage, describe how you could produce the following atmospheres: (a) supernatural—the figure is an angel or a friendly alien; (b) eerie—the figure is evil, a murderer, perhaps; (c) comic—the figure is a happy clown.
2. Why do people working on costumes, makeup, and set painting need to communicate with the lighting crew?
3. How might natural light sources such as sunlight affect the light plot?
4. Why is speaker placement important?

FOCUS ON**Stage Technicians**

If you love science, computers, or working with your hands, good news. Your skills are much needed in the theater. The people who build the sets, handle the props, and run the equipment are vital to the success of any professional production.

Exploring Careers Learn more about how to turn mechanical or technical skills into a career in the arts. Choose one of the following to research: lighting technician, sound board operator, carpenter, or stage manager. Besides finding information in books and on the Internet, you may want to write a letter to

your local theater company requesting an interview with one of their stage technicians. Share what you learn with the class.

Comparing Careers Choose an arts career that you learned about in a different chapter, such as musician or radio announcer. Then make a chart comparing and contrasting that career with the technical career you researched. Your chart should show the training, skills, and discipline each career path requires. Which career would suit you better? Write a paragraph explaining your answer.

REVIEW WORKSHOP

LIGHTING AND SOUND

INDEPENDENT ACTIVITIES

Supporting Pantomime Imagine that you have been asked to do the sound and lighting for a pantomime. The performer will be dressed in mostly white (with only a few touches of black) and will wear white makeup. How will you highlight the subtlety of gesture and expression? What sound effects and music will add to the performance? Create a detailed light plot for the pantomime

presentation. Explain to your classmates the rationale for your decisions, and demonstrate, if possible, how this performance will look under the lights. Describe and demonstrate your sound effects and music.

Music and Sound Effects Select several poetry excerpts from the Application Activities in Chapter 3, and plan a poetry reading. Devise music and sound effects that will enhance the poems. If possible, produce a recording of your sound track for the class and have someone read the poetry in time with your sound cues.



Cooperative Learning Activity

Creating Mood and Atmosphere

Color, light, and sound add emotional overtones that can either support or detract from the overall effect of a dramatic presentation. With a group of your classmates, discuss the colors, lighting effects, music, and sound effects that you would use to create the following atmospheres or moods.

- A reunion between a pair of long-separated lovers
- An enchanted forest
- A secret attic room that has not been entered for twenty-five years
- A family gathering with a typical mixture of affection and conflict
- The office of an executive who is about to be fired

Across the CURRICULUM Activities

Science In a play, lighting has the capacity to establish important background information

about the time of day, the weather, and even the season during which the action takes place. Based on what you know about the positions of the sun and the moon and weather in general, how might you show changing time and weather conditions onstage? Write a brief report as part of your planning.

History During the Middle Ages there were distinct differences between the ways in which nobility and serfs lived. Imagine that your drama club is doing a production with a medieval setting and you have been asked to design the lighting. How will you show the differences between the classes? Create a light plot that illustrates your solution.