Improving the Sounds of Your Ensemble Recordings

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PRESENTED BY

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MUSIC & THEATRE
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PRELIMINARY QUESTIONS & CONSIDERATIONS

There are many approaches to achieving an excellent recording of your ensemble. Whether you use a standalone recorder or a computer with digital interface, there are a few key elements that will help you understand how to achieve the sound you are searching for:

1. Understanding the various types of microphones and their specific applications.
2. Microphone placement techniques and how they affect the stereo image.
3. Ensemble seating.
4. Trusting your ears.
5. Purpose of your recording (archival, assessment, audition, commercial)

One of the other elements that I recommend that you consider is how often you will be needing to record your ensemble. This may guide your decision on what gear to purchase, based on how simple or how complex of a set up you need. For example, do you wish to record rehearsals for your own rehearsal planning, then a simple standalone recorder maybe sufficient. Consider the following:

1. Do you wish to record rehearsals to provide immediate feedback and listening opportunities for your students?
2. Do you wish to use your recording for rehearsal planning?
3. Do you wish to make an archival recording or an audition recording?

Simple vs. Complex Setup

Determine your comfort level with the equipment and computers. Often, your available budget can often determine the size and complexity of your set up. Will you be making the recordings yourself or will someone else be helping you?

This handout will help explain the various elements of recording and serve as a reference resource.

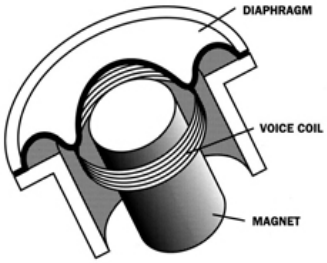
UNDERSTANDING MICROPHONE TYPES

NOT ALL MICROPHONES ARE CREATED EQUAL

The two most popular types of microphones are dynamic microphones and condenser microphones. Dynamic microphones, such as the popular Shure SM 57 are mostly commonly found in live performance and are better suited for this purpose. Condenser microphones have a greater sensitivity and can achieve greater details and more accurate results when recording

DYNAMIC MICROPHONES:

Dynamic microphones contain a diaphragm, voice coil, and magnet assembly that form an electrical generator that is driven by sound waves. Dynamic microphones do not require additional power to respond. Therefore, it takes more effort (louder volumes) to cause the diaphragm to vibrate. This makes dynamic microphones less susceptible to feedback and thereby more favorable for live performance.

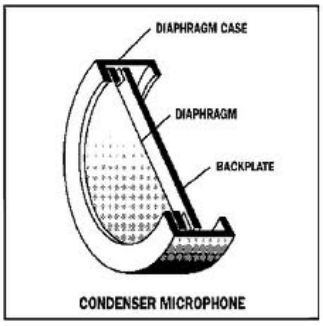


DYNAMIC MICROPHONE

SHURE SM57 SM58

CONDENSER MICROPHONES:

Condenser microphones respond much faster and are therefore more sensitive than dynamic microphones. They use an electrically charged diaphragm assembly that requires *phantom power* (+48v) to operate. Condenser microphones can pick up a great level of detail and typically produce a higher quality sound making them ideal for recording. Please note that most recording devices, mixers, digital interfaces, standalone recording include a *phantom power* switch that must be turned on to give condenser microphones power. Condenser microphones come in small diaphragm (RØDE NT5) and large diaphragm versions (AKG414).



CONDENSER MICROPHONE

RØDE NT5 AKG 414XLS

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UNDERSTANDING POLAR PATTERNS AND DIRECTIONALITY

MOST COMMON

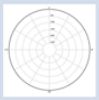
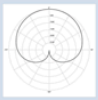
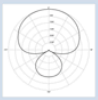
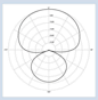
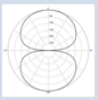
CARDOID: Picks up sound from the front of the diaphragm in a heart-shaped pattern covering an angle of 130°. This pattern is good (and recommended) for rejecting the audience sound behind the microphone. Less expensive than Omni-directional microphones and in my opinion, better suited for a rehearsal room.

OMNI–DIRECTIONAL: This pattern picks up 360° around the microphone. This pattern also brings out the "lows" and is recommended if you have a great sounding hall and want to capture the "hall sound."

*The remaining patterns shown on the left are less common. The polar response pattern shows the pickup or listening area for each microphone and the 'null' points where the sound is rejected.

*Most condenser microphones only offer one pattern while some of the more expensive ones may offer multiple patterns by including a switch that toggles between them.

POLAR PATTERNS EXPLAINED

Characteristic	Omnidirectional	Cardioid	Supercardioid	Hypercardioid	Bi-directional
Polar response pattern					
Coverage angle	360°	131°	115°	105°	90°
Angle of maximum rejection	N/A	180°	126°	110°	90°
Rear rejection (relative to front)	0	25dB	12dB	6dB	0dB
Ambient sound sensitivity	100%	33%	27%	25%	33%
Distance factor	1	1.7	1.9	2	1.7

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UNDERSTANDING MICROPHONE PLACEMENT

The next step after choosing a pair of condenser microphones is to consider their proper arrangement and placement to achieve a good stereo image representation of your ensemble's performance. Placement can make a significant difference in the quality of your recording. It can mean the difference between an unclear and "tubby" sounding recording or one that is clear and well balanced.

Humans hear in stereo (Right-Left). Using two condenser microphones in a stereo configuration will give you greater depth and give you more natural spatial representation of your ensemble in your overall recording. Except for the *Mid-Side* and *Spaced* configurations, the two condenser microphones in each of these techniques can be set up on a single microphone stand using a stereo bar. Each technique listed below offers its own advantages.

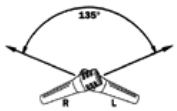
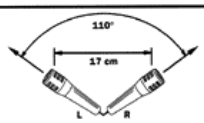
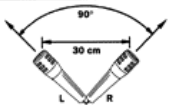
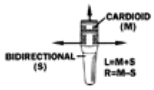
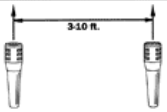
COMMONLY USED TECHNIQUES

X-Y:
Uses two *cardioid* microphones arranged with the capsules over each other. Stereo image is narrow. Good center image. Less pronounced L-R separation in stereo image.

ORTF:
This technique was developed in 1960 by the Office de Radiodiffusion Télévision Française (ORTF). Provides a realistic stereo image with good L-R separation.

SPACED (A/B):
Uses two cardioid or two Omni-directional microphones spaced 3-10ft apart and panned to the left and right. Stereo separation is very wide and susceptible to phasing problems.

Using 3 Microphones:
3 condenser microphones setup:
Left–Center–Right. The distance between microphones should be at least 3x times the distance from the ensemble at a ratio of 3-to-1. Ex. Mics 3ft apart for every 1ft in front of the ensemble.

STEREO PICKUP SYSTEMS	MICROPHONE TYPES	MICROPHONE POSITIONS	
X-Y	2 - CARDIOID	AXES OF MAXIMUM RESPONSE AT 135° SPACING: COINCIDENT	
ORTF (FRENCH BROADCASTING ORGANIZATION)	2 - CARDIOID	AXES OF MAXIMUM RESPONSE AT 110° SPACING: NEAR-COINCIDENT (7 IN.)	
NOS (DUTCH BROADCASTING FOUNDATION)	2 - CARDIOID	AXES OF MAXIMUM RESPONSE AT 90° SPACING: NEAR-COINCIDENT (12 IN.)	
STEREOSONIC	2 - BIDIRECTIONAL	AXES OF MAXIMUM RESPONSE AT 90° SPACING: COINCIDENT	
MS (MID-SIDE)	1 - CARDIOID 1 - BIDIRECTIONAL	CARDIOID FORWARD-POINTED; BIDIRECTIONAL SIDE-POINTED; SPACING: COINCIDENT	
SPACED	2 - CARDIOID OR 2 - OMNIDIRECTIONAL	ANGLE AS DESIRED SPACING: 3-10 FT.	

STEREO MICROPHONE TECHNIQUES
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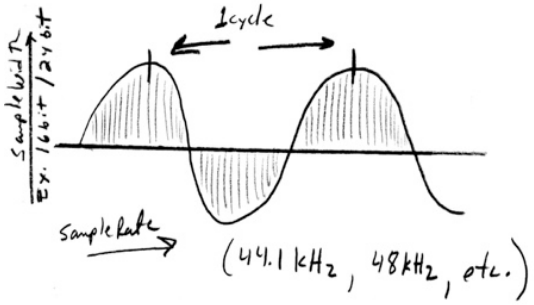
Microphone Placement: (XY, ORTF setups work best by using a stereo bar mounted on a single microphone stand).
How far back from and how high you place your microphone setup away from your ensemble can dramatically change the sound of your recording. It may take a little experimentation with each of these variables to determine where your recording will sound the best. Once you find the "sweet spot," take note so that you can repeat every time. Don't be afraid to experiment!
Things to consider:

- Experiment by placing your microphone stand about 4 feet away from the ensemble and about 7-8 feet high and then gradually move up to 10ft back and 10ft high.
- Finding a good combination of distance and height will allow the instruments/voices in your ensemble the opportunity to blend better with each other.
    - The further away you place your microphones from your ensemble, the more "room" you will hear in your recording. Too much room can cause your recording to sound 'tubby' and unclear.
    - If your room is very live (too much echo), move your mics closer to the ensemble. The closer your mics are to the ensemble, the more you will hear articulation and individual instruments/voices.
- Feel free to also adjust your ensemble's seating arrangement to also achieve the sound you want. For example, if you are not getting much of a particular instrument or voice in your recording, try moving it closer to front of the ensemble.

RECORDING RESOLUTION QUALITY & FILE FORMATS

This section may get a little technical. Don't be afraid. Having the proper settings on your standalone digital recorder or computer software can make a big difference in the quality of your digital recordings.



Sampling Rates: This refers to the n*umber of samples (pictures)/per second* measured in hertz (Hz) that convert the analog sound too digital. The more samples, the more detail captured.

Bit Depth or Resolution: This is similar to the resolution on a camera or graphics on a computer. It represents the *number bits per sample*. The greater the number, the higher quality of the recording. A higher bit depth will yield the wider the dynamic range, less noise, and a warmer sounding recording.

Recommended Settings for Recording Audio:

- Best to record to an uncompressed audio file format such as .AIFF or .WAV. on your standalone recorder or computer software. Below are a couple of sampling rates/bit depth I recommend using to record or .AIFF or .WAV files:
  - 44.1kHz/16bit yields a CD quality recording. This is a good starting place.
  - 48kHz/24bit is my preferred setting for a little detail and warmer sound.
- Try to avoid recording onto a compressed file format such as an .MP3 or .AAC format.

Digital Audio File Formats for Recording and Exporting Audio:

- Uncompressed (full-quality) Audio Files – Used to create CD compatible files and high-end audio.
  - .AIFF (Mac)
  - .WAV (PC)
- Compressed Audio Files – Used to save space, streaming, iPods, and other portable media players. Create smaller file sizes by eliminating data.
  - .MP3
  - .AAC (Apple iTunes)
- Most audio software will allow you to choose the sampling rate and bit depth when you export/save your audio files.
- If you are exporting audio files to burn onto a CD, remember to export your audio as a .WAV or .AIFF formatted file at 44.1kHz/16bit.
- Compressed audio file formats such as .MP3 often compromise the quality of your recorded audio. If you must compress your audio files to save space, try to export using the highest bit rate setting available.

The chart below shows the approximate disk/memory space required by each of the file types and sampling rates listed above.

Bit Depth	Sample Rate (kHz)	One Minute (2-channel Stereo)	CD Capacity 700 MB	SD Card Capacity 4 GB	SD Card Capacity 8 GB	SD Card Capacity 16 GB
16	44.1	10 MB *uncompressed*	80min	6hrs 17 min	12hrs 35min	25hrs 11min
24	48	16.5 MB *uncompressed*	*	4hrs 18 in	8hrs 17min	16hrs 34min
Mp3 file	128 k/bit rate	.94 MB *compressed*	*	69hrs 26min	138hrs 53min	277hrs 46min

PUTTING IT INTO PRACTICE

How to set your recording levels

Setting Up for Your First Recording:

There are two important concepts to remember:

1) The input/recording volume (aka ***Trim***) on your recording device (standalone recorder or computer interface) only controls the amount of sound coming in from your microphone.

2) Your output volume only controls the volume to your speakers (monitors) or headphones. Trim and volume are independent of one another. Adjusting the volume of your headphones does not adjust the volume of your microphones.

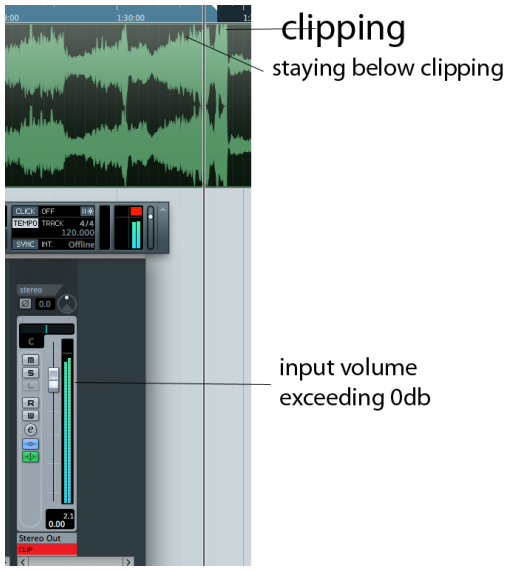
How To Set Your Trim:

- Your trim can be set up through the buttons or knobs on your standalone recorder or digital interface.
- It is important to set your input level appropriately to avoid overloading your microphone, which may result in digital distortion or "clipping."
- Test your settings by asking your ensemble to perform short excerpt from the loudest passage in their music.
    - On your device, adjust your trim up or down until your loudest passage stays consistently below the 0 decibel (dB) mark. You may consider keeping your loudest signal between -12dB and -6dB to give you some *headroom* when recording. This will help ensure that your signal does not exceed 0dB during your actual recording. Most devices will show you a red meter reading if your signal is too "hot."
- If your signal is too "hot," you may get distortion in your recording. Once the distortion has been recorded, there is no way to save your recording. If your levels are too low, you can always bring up the sound level of your recording by "normalizing" your final levels from within your computer software.
- Most devices retain your settings for trim, file type, sampling rate, bit depth, etc. So, once you've figured out the settings that work for you, you can keep them and use them each time you record.

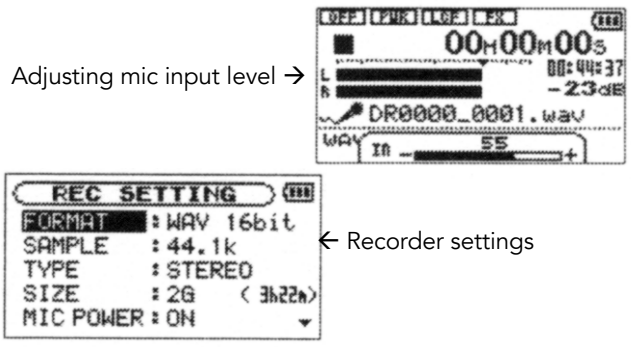
A Few More Tips:

- Have a plan on what you wish to record. Will you record a single take, multiple takes to be edited together later (have a "take list"), or a concert performance? This will help you plan your ensemble rehearsal, and lessons.
- Restart your computer, so that the memory is cleared.
- Record onto a dedicated hard drive.
- Turn off your WiFi, Bluetooth, and notification settings on your computer.

<u>Screen Shot: Cubase</u>



<u>Screen Shot: Tascam DR-07 Digital Handheld Recorder</u>



MICROPHONE RECOMMENDATIONS

Condenser Microphones: Below are a few microphone recommendations at various price points. I have used most of these with good results. Remember that for a stereo configuration, you will need to purchase two microphones. These microphones can be used with standalone recorders and also with a variety of computer interfaces. Please note that a stereo pair of microphones can be heavy. You may want to invest in a heavy boom stand or stand with counterweights.

Small Diaphragm Condenser

AKG P170 $99.00ea
www.sweetwater.com/store/detail/Percep170

Rode NT5-S $219.00ea
www.sweetwater.com/store/detail/NT5Sing/

Shure SM81 $399.00ea
www.sweetwater.com/store/detail/SM81

Neumann KM184 $1,483.35pair
www.sweetwater.com/store/detail/KM184Pair

Large Diaphragm Condenser

Superlux CM-H8B $143.00ea
https://www.performanceaudio.com/products/superlux-cm-h8b-1-large-diaphragm-cardioid-condenser-microphone

Shure KSM32 $599.00ea
www.sweetwater.com/store/detail/KSM32CG

AKG C414XLII $1319.00ea
www.sweetwater.com/store/detail/C414XLII/

**estimated prices*

GETTING TO KNOW YOUR MICROPHONE CABLES AND CONNECTORS

Balanced Cables: XLR microphone cables are considered *balanced cables.* They contain three pins: Pin 1= Ground, Pin 2=Positive, Pin 3=Negative. The positive and negative pins carry opposite signals and together, they block out unwanted sounds and interference. They retain their quality and integrity of sound over longer cable runs. Unbalanced cables are more susceptible to interference and degradation of sound signal over longer runs.

Balanced ¼" Cables (TRS–Tip/Ring/Sleeve): Balanced ¼" cables work the same way. Tip=Positive, Ring=Negative, Sleeve=Ground

Balanced XLR Microphone Connector

Balanced TRS ¼" Connector

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RECORDING SETUP ACCESSORIES

On-Stage SB9600 Tripod Boom Mic Stand $177.95
Perfect stand for setting up a stereo pair of condenser mics.
www.sweetwater.com/store/detail/StuBoom/

Shure S15A Telescoping Microphone Stand $228.00
www.sweetwater.com/store/detail/S15A

Pro Co EXM-50ft Microphone Cable $47.99
www.sweetwater.com/store/detail/XLR50

Gaff Tape (Leaves minimal to no residue) $19.95
https://www.sweetwater.com/store/detail/Gaff255Blk--pro-tapes-and-specialties-pro-gaff-premium-2-inch-gaffers-tape-black

K&M 23510 Adjustable Stereo Microphone Bar $21.99
Perfect for setting up an ORTF, NOS, or XY mic configuration.
https://www.sweetwater.com/store/detail/KM23510--k-and-m-23510-adjustable-stereo-microphone-bar

On-Stage Female to 1/4"-20 Camera Adapter
Perfect for mounting your handheld recorder onto a mic stand.
www.sweetwater.com/store/detail/MA125OSS $4.95
https://www.sweetwater.com/store/detail/MM01--on-stage-stands-mm01-ball-joint-mic-adapter $11.95

HANDHELD RECORDER VS. COMPUTER INTERFACE

- A few questions to consider before purchasing equipment:
  - Are you a computer person or do you prefer a standalone device?
  - Do you need something portable?
  - How often are you recording?
  - What is the purpose of your recording?
  - How much post-production editing do you plan to do, if any?

- Handheld recorders:
  - Do you need a simple recorder, or do you want a recorder that has effects such as reverb and tools such as a tuner, metronome, and variable speed control?
  - Is there software bundled with the hand held recorder?
  - Some recorders have XLR and ¼"inputs so you can add your own larger condenser microphones, a guitar, or keyboard.

- Computer Interfaces
  - How many inputs do you need? XLR Microphone (2 microphones for stereo recording), ¼" instrument, MIDI.
  - What is the capture quality of the interface? Most offer up to 24bit/96k.
  - Does the interface offer metering lights on the front panel, so you can monitor the microphone input level?

- Determine your budget (minimum/maximum you can spend). Sometimes it is better to first consider your purpose and then prepare a "wish list" then fundraise for what you need.

HANDHELD RECORDER RECOMMENDATIONS

Zoom H4n Pro Handy Recorder **$169.99**
24-bit/96kHz Digital 4-track Recorder w/2 Built-in Microphones, XLR and hi-Z Inputs, 50 Onboard DSP Effects. Bundled with Cubase LE8. ***Doubles as a computer interface!* XLR inputs allow you to use your own condenser microphones.
https://www.sweetwater.com/store/detail/H4NPro--zoom-h4n-pro-handy-recorder

Zoom H1n – VP2-Chanel Handy Recorder **$119.99**
Mobile 24bit/96kHz Audio Recorder with Onboard Stereo XY Microphones and 1/8" Stereo Mic-Line Input
https://www.sweetwater.com/store/detail/H1N-VP--zoom-h1n-vp-2-channel-handy-recorder

TASCAM DR-05X Stereo Handheld Recorder **$89.99**
2-channel Handheld Recorder and 2-in/2-out USB Audio Interface with 2 Omnidirectional Condenser Microphones
https://www.sweetwater.com/store/detail/DR05X--tascam-dr-05x-stereo-handheld-recorder

TASCAM DR-40X 4-Channel **$154.99**
4-track Handheld Recorder with Adjustable Onboard Microphones and XLR Combo.
https://www.sweetwater.com/store/detail/DR40X--tascam-dr-40x-handheld-recorder

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DIGITAL INTERFACE RECOMMENDATIONS

It is safe to say that today almost all digital interfaces are compatible with both MAC and PC computer platforms and most any recording software that you wish to use. Most devices offer USB connections. Some of the mid-rage to higher end devices will offer both USB and Fire wire connections to your computer. Listed below are a few recommendations to get you started. Of course, high end interfaces can cost well over a thousand dollars.

Zoom U-24 Handy Audio Interface **$159.99**
24-bit/96kHz 2-channel Portable USB Audio Interface with 2 Preamps, MIDI I/O, and Bus/Battery Power. Bundled with Abelton Live 9 Lite.
https://www.sweetwater.com/store/detail/U24

Steinberg UR22C - USB **$194.99**
Bundled with *Cubase AI* recording software.
https://www.sweetwater.com/store/detail/UR22C--steinberg-ur22c-usb-audio-interface

Focusrite Scarlett 2i4 - USB **$279.00**
Bundled with light versions of *Avid Pro Tools* recording software.
https://www.sweetwater.com/store/detail/Scar4i4G4--focusrite-scarlett-4i4-4th-gen-usb-audio-interface

MOTU Audio Express USB/Firewire **$395.00**
Also includes MIDI jacks. Can also double as a small mixer. 2 XLR preamps and 2 balanced ¼ inputs. Includes front panel metering.
https://www.sweetwater.com/store/detail/AudioExpress

MOTU 8pre USB **$549.00**
16-in/12-out USB 2.0 Audio Interface, 24-bit/96kHz, with 8XLR Mic Preamplifiers, ADAT I/O, and CueMix DSP.
http://www.sweetwater.com/store/detail/8preUSB

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DIGITAL AUDIO RECORDING SOFTWARE

Most Software Companies Offer Free Trial Versions and Educator Versions at a Discounted Price.

Audacity and **Garage Band** both provide several entry level tools for recording and editing.

Audacity $FREE
http://audacity.sourceforge.net/

Garage Band $FREE
https://itunes.apple.com/us/app/garageband/id682658836?mt=12

More robust DAW (Digital Audio Workstation) Software is listed below. These are the three most popular DAW's used by the recording industry. Some companies offer entry level or slimmed down versions of their software either free or at a very reduced price. These versions are often bundled for free with the digital interface or hand held recorder you choose to purchase (see chart above).

Steinberg Cubase Elements 13 (Education) $66.99
https://www.steinberg.net/en/shop/education.html

Avid Pro Tools 12 for Students $99 (yearly school subscription)
https://www.sweetwater.com/store/detail/PTSubAnnEdu-e--avid-pro-tools-with-1-year-of-updates-and-support-plan-academic-institution-1-year-subscription-download

Logic (Apple) $199.99
https://itunes.apple.com/us/app/logic-pro-x/id634148309?mt=12

HEADPHONE RECOMMENDATIONS

Headphones: A well-balanced quality pair of headphones is important for critical listening and for editing. They can bring out greater detail and give you a more realistic/natural aural reproduction. Closed-Circumaural headphones provide better isolation of sound and keep sound from leaking out. Semi-open, Circumaural headphones breathe a little more and provide a wider dynamic range and sensitivity. Buying a great pair of quality headphones is not only important to your listening experience, but also may last much longer (often 10+yrs) than an inexpensive $10 pair. Learn more about headphones: http://www.headphone.com/learning-center/

AKG K240 Studio $85.00
Professional Studio Semi-open, Circumaural Studio Headphones. This design allows a wide dynamic range and provides great detail.
http://www.sweetwater.com/store/detail/K240S/

Sony MDR-7506 $99.00
Closed Circumaural Headphones. Closed-back design provides better isolation and consistent listening.
http://www.sweetwater.com/store/detail/MDR7506/

Audio-Technica ATH-M50S $149.99
Closed Studio Headphones. Provides better isolation and consistent listening.
http://www.sweetwater.com/store/detail/ATHM50S/

STUDIO MONITOR SET-UP

Monitors
Monitor speaker setup is very important to achieving a well-balanced sound in for listening and editing. For optimal results, your studio monitors should be placed at ear-level and angled in to form a triangle with your head. This is the "prime listening position." It is recommended to place your monitors on a foam base or a pair of adjustable monitor stands.

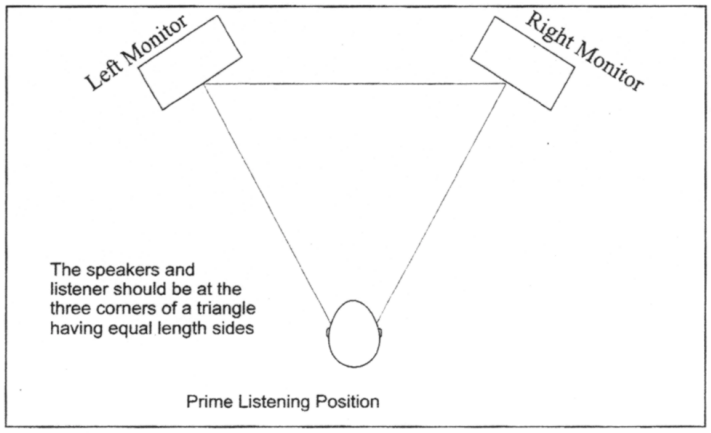

Illustration from Alesis M1 Active Mk2 Monitor User Manual

STUDIO MONITOR RECOMMENDATIONS

KRK Rokit 5 G4 5" $189.50 (each) *note you will need 2
5" Bi-amplified Near Field Studio Monitor with Kevlar/Agamid Woofer, Soft-dome Tweeter, and High- and Low-frequency Controls.
https://www.sweetwater.com/store/detail/Rokit5G4--krk-rokit-5-g4-5-inch-powered-studio-monitor

Alesis Elevate 5 MKII 5" Powered Studio Monitors $139.00 (Pair)
5" Powered Studio Monitors with 5" Woofer, 1" Silk Dome Tweeter, and 56Hz-20kHz Frequency Response (pair)
https://www.sweetwater.com/store/detail/Elevate5MkII

JBL 305P MkII 5" Powered Studio Monitor $149.00 (Each)
82W Powered 2-way Studio Reference Monitors with 5" Woofer, 1" Tweeter, and Magnetic Shielding (each)
https://www.sweetwater.com/store/detail/LSR305MK2

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Please visit websites for more in-depth listing of features.

RECORDING IN YOUR CLASSROOM

Using recording techniques to enrich your ensemble rehearsals

Teacher Self–Assessment & Action Research

- Record your rehearsals and consider the following questions & suggestions:
  - How was your pacing?
  - Were your instructions clear?
  - Did you accomplish your rehearsal goals? Did your ensemble clearly understand and apply your instructions?
- Application
  - Use your observations from listening to plan your next rehearsal(s). Recording can help you add focus your lesson plans.
  - Share your findings with your students. I like to write down my "laundry lists" and share with each section. I take this opportunity to have students write my comments/corrections into their parts with their pencils. This can save you a lot of rehearsal time and increase your effectiveness.

Student Self-Assessment:

- Playing back rehearsal recording for your students will help them to listen critically and evaluate their performance.
  - Have students listen to their rehearsals a couple of weeks before their festival contest. Ask them to listen critically and evaluate their performance using the large group contest adjudication form.
  - Ask students to make a list of what they need to do better as an individual and as a section.
  - Recording your ensemble at various points in your rehearsal/preparation period for festival can help you and your students assess improvement.
- Rehearsal recordings can be used to provide immediate feedback during rehearsals.
  - Record a passage and immediately play it back for your ensemble so your students can hear if they are meeting their musical goals. Sometimes the group may think that their articulations are clear or that their balance is good until they listen to a recording of themselves. Ask students to evaluate their performance, make changes, and then record the same passage again so that the ensemble can hear their improvement.

QUICK GUIDE TO COPYRIGHT FOR SOUND RECORDINGS

FAIR USE	INFRINGEMENT
Make a single recording of a student performance for study and or school's archive	Make multiple copies of a recording of a student performance without paying the appropriate mechanical-licensing fees, even if a fee is not charged for a copy
Copy songs from a legally obtained CD to create a compilation (for personal use)	Copy songs from a legally obtained CD to create a compilation for someone else
Use legally obtained personal CDs (including compilations) in the classroom for evaluation, rehearsals, exercises, or examinations	Downloading music from peer-to-peer file-sharing services without paying for it (unless it is a legal service)
Download MIDI files of public-domain music and perform them for students	Download or upload MIDI files of music that is protected by copyright
Download audio files for which the copyright holder has given permission to do so	Make copies of accompaniment CDs for students (unless the publisher grants permission to do so)
	Include a copyrighted sound recording (a sample-even if it's less than 1 second) in a new recording without obtaining an appropriate licensing agreement
	Post recordings on a website without the permission of the publisher (even if less than 10% is used)

Frankel, James (2009). *Teacher's Guide to Music, Media, and Copyright Law.* New York: Hal Leonard. Page 175

PRINT RESOURCES

Frankel, James (2009). *Teacher's Guide to Music, Media, and Copyright Law.* New York: Hal Leonard
ISBN: 978-1-4234-4344-5

Manzo, V.J. (2016). *Foundations of Music Technology.* Oxford University Press.
ISBN: 978-0199368297

Menasché, Emile. (2011) *Your Sound Onstage.* Hal Leonard Corporation.
ISBN: 978-1617742316

Thompson, Daniel (2005). *Understanding Audio,* Boston; Berklee Press
ISBN: 0-634-00959-1

ONLINE TECHNOLOGY RESOURCES

UNDERSTANDING SOUND

- Fun video for your students on sound
  www.youtube.com/watch?v=_ovMh2A3P5k

- Sound Pressure Level, Decibel Table, Loudness Comparison Chart – *A great resource for understanding loudness, threshold of hearing and hearing safety.*
  www.sengpielaudio.com/TableOfSoundPressureLevels.htm

- Musical Instruments – *This site explains the acoustic properties of various musical instrument.*
  hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1

RECORDING GUIDES/TOOLS

- Shure: *Audio System Guide for Educators*
  Microphone Techniques Live Sound Reinforcement & Recording
  https://content-files.shure.com/Pubs/microphone-techniques-for-live-sound-reinforcement/microphone_techniques_for_live_sound_reinforcement_english.pdf

- Principles of the ORTF Stereo Technique
  www.dpamicrophones.com/mic-university/principles-of-the-ortf-stereo-technique

- Audio Check – Test your equipment and more!
  www.audiocheck.net/index.php

- Test Your Speakers – Outlier Studios
  https://youtu.be/2ZrWHtvSog4

AUDIO SOFTWARE (most software programs have an entry level version and/or educational version)

- Audacity (free audio editing/recording software) – https://sourceforge.net/projects/audacity/

- Cubase (Education) – https://www.steinberg.net/education/shop/

- Protools by AVID (Education) –
  https://shop.avid.com/ccrz__ProductDetails?isCSRFlow=true&rdp=1704302667366&sku=DYNA20002&viewState=DetailView&cclcl=en_US

- Logic – https://apps.apple.com/us/app/logic-pro-x/id634148309?mt=12
  Education Bundle – https://www.apple.com/us-edu/shop/product/BMGE2Z/A/pro-apps-bundle-for-education

NOTATION SOFTWARE (most software programs have an entry level version and/or educational version)

- Finale (Education) – https://www.finalemusic.com/products/finale/special-pricing/
- Noteflight (Education) – https://www.noteflight.com/learn
- Sibelius – https://www.avid.com/sibelius

FREE – MIDI, SOFTWARE

- Musescore *FREE! – Music Notation* – https://musescore.org/en
- Aria Maestosa *FREE!* – MIDI Sequencer/Editor – https://ariamaestosa.github.io/ariamaestosa/docs/index.html
- *Garage Band FREE (Apple)* – Digital Recording & Editing – http://www.apple.com/mac/garageband/
- *Audacity FREE!* – Digital Recording & Editing – http://www.audacityteam.org/

IPAD & IPHONE APPS

- Tonal Energy Tuner (Equal Temperament & Just Intonation@) ($3.99)
  https://tonalenergy.com
- {Newzik – Music score management and reading app ($19.99 basic & lifetime or $39.99/year for the full featured version)
  https://newzik.com/en/

HEADPHONES

- Learn About the Various Types of Headphones and How They Work
  https://www.headphone.com/pages/headphone-101

CABLES & CONNECTORS

- How Cables Work (Everything you ever wanted to know!)
  https://blog.landr.com/audio-cable-types-guide-infographic/
- Audio Connector Guide (Learn About Cable Connectors)
  www.cablestogo.com/learning/connector-guides/audio

COPYRIGHT

- Copyright Center (NAfME): https://nafme.org/my-classroom/copyright/

PROFESSIONAL ORGANIZATIONS & TECHNOLGY STANDARDS

- NAfME – National Music & Technology Standards.
  www.nafme.org/my-classroom/standards/

- ISTE – International Society for Technology in Education.
  www.iste.org

- TI:ME – Technology Institute for Music Technology.
  cdn.shure.com/publication/upload/401/us_pro_audiomusiceducators_ea.pdf

STANDARDS FOR MUSIC TECHNOLOGY

- NAfME Music Technology Standards
  https://nafme.org/my-classroom/standards/core-music-standards/

- INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION (ISTE) STANDARDS
  https://www.iste.org/about/about-iste

ELEMENTARY/GENERAL CLASSROOM MUSIC TECH RESOURCES

- CUED IN BLOG (JWPEPPER) https://blogs.jwpepper.com/index.php/building-an-advanced-music-lab-in-your-classroom-part-one-elementary/

BUILDING A LAB

- CUED IN BLOG (JWPEPPER) https://blogs.jwpepper.com/index.php/building-an-advanced-music-lab-in-your-classroom-part-one-elementary/

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