

K7QO's Code Course

Version 3.0
by Chuck Adams, K7QO

My name is Chuck Adams and my call is K7QO. I will be your mentor for this course. I have been doing Morse code since 1957 and it is my favorite mode of communication in ham radio. That does not make me an expert on the topic, but I do want to give you what I know and you can modify it to fit your needs. But I have seen too many people learn the Morse code the wrong way and then quit when they couldn't get faster. Let's not let that happen to you.

The Morse code may not come easy and in order to get proficient at it you must devote an appreciable amount of time to it. My job is to guide you through the swamp of bad habits and keep you from falling into the quicksand.

I did not start out with a mentor. My dad, W5NNB, felt that he could not teach me the code, since I was his son and probably wouldn't listen to him. So he took me to a ham meeting in Kermit (12 miles away from Wink, TX) and I met some kids my age. This was on a Thursday night. They told me to go home and memorize the code and come back on Saturday and they would start helping me.

And that is what I did. I went back home and started with an Instructograph machine that used paper tapes with holes in them to generate the code. I used a single tube audio oscillator

with it to generate the tones. Since I didn't have any one to help me for two days, I started out memorizing the letters using the Instructograph and the manual. On Saturday I went to Terry's, K5WNH, and he and a friend of his sat me down and gave me a test. They asked me how much of the alphabet and numbers had I memorized and I told them all of them. They said "Sure" and began the test. I was doing 12WPM without errors.

What made this possible was the fact that I memorized the letters and numbers at a higher speed than most people probably started teaching in any course. And I did not use any charts, cute little tunes, and other crutches that will later slow you down. If you learned the code any other way than rote memorization of the sounds, you may need to start over. Any one that teaches or shows the Morse code with dots and dashes or other visual aids is killing off high speeds and ruining a bunch of good minds. I'll explain later. Don't use any materials or computer programs that show you dits and dahs, etc. for feedback. Only the letters and characters themselves.

There are a number of people running around that claim you should not use tapes and CDs to learn the code. They claim that it is possible for you to memorize the materials. So what? Didn't we all memorize "See Spot"? And if you memorize all the material on this disc I will buy you a Krispy Kreme donut the next time I see you. There are over 20 hours of Morse on this

CD and not a human voice to be heard.

A few years later after I obtained my Novice license I got a set of vinyl records made by Conan W.B. Barger, W3CVE, that made up about 2 hours of code practice. With that set of records (and I have them copied to CD now, but the audio quality is bad) I practiced and got to over 55WPM with them. But that required the variable speed phonograph player to obtain the higher speeds with the same physical tracks on vinyl.

Conan mentions on his record that CW operators are not born but are trained. This is probably true of a majority of the things the human race does. You just have to set aside the time to practice and get good at this if you really want to do it. You can't do it in one day, so set aside some time each day and you will do well.

Course Outline

In this course I will teach you how to do three things. It is my hope and my wish that you learn all three techniques for copying code and not skip one or more of them. You should learn each as each has advantages and you should be able to do any of them. But only you will know how much time you want to devote to learning this mode of communication. I can not do it for you.

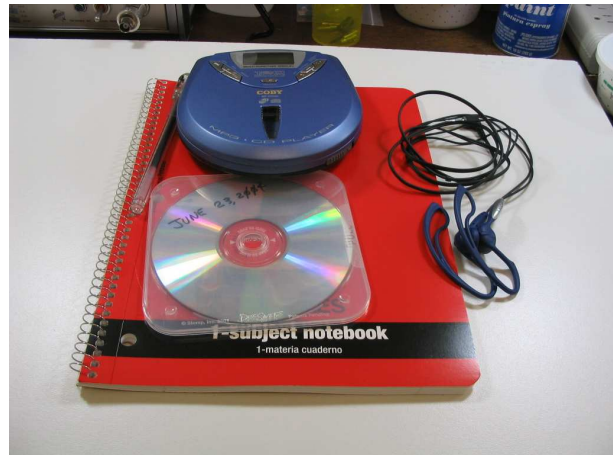
- Copy Morse code using pen and paper.

- Copy Morse code using a typewriter or keyboard.
- Copy Morse code in your head without hard copy.

Materials You Will Need

This is a list of the materials that I recommend that you start with for this course.

- A Spiral Notebook.
- A rolling writer type pen.
- A portable MP3 player, either using CD or an iPod.
- The K7QO Code Course CD.
- A good set of headphones for the player.
- Time.



Materials Needed.

Spiral Notebook

I recommend a spiral notebook for several reasons. I buy them from Staples where I can get 6 of the single subject notebooks for under five dollars including tax. I like a notebook that lies flat on the desk when open and I can write on front or back of pages without any problems. And I want you to be proud of the work that you do for this course and keep it all together in one place. Later I am going to give you an exercise that requires you to take everything for this course out into the real world.

I started out with a novice class license in 1957 as KN5FJZ and I wrote down everything that I copied and to this date I still do the same thing. I use the spiral notebooks to record everything during a QSO and then later transfer the date, time, and other information to a computerized logbook. When I was a senior in high school I filled up nine ARRL logbooks with one QSO per line in a period of one year operating only on 40 meter CW using a Heathkit Apache transmitter and a NC-300 receiver. I even had a QSK setup made up of two 1N34 diodes and a 5W 120V bulb in a small metal box. I wrote down everything I heard to paper.

Also in the same time period from the mid- to late-50's a great deal of CW activity occurred in the commercial broadcast bands. Remember. This was before the age of computers, satellites, CNN, and cell phones. Both commercial cargo ships and passenger ships at sea could only get

the news via CW stations that broadcast the news daily on certain frequencies. UPI, API, and the wire services at the time ran several stations that did this. I remember some of them and list them here for historical purposes.

- WSC from NY at 25WPM
- NPG from CA at 12-26WPM
- WNU from LA at 16-25WPM
- KPH from CA at 18-22WPM
- WAX from FL at 16-25WPM
- NPM from HI at 12-26WPM
- WOE from FL at 16-25WPM
- KPH from CA at 18-22WPM
- WCO from NY at 22WPM
- WFK from NY at 30WPM

Most of the stations were on daily and at specific times and frequencies while others were on only a day or two per week. The radio operator on each of the ships would copy the daily news using a mechanical typewriter and then post the news on a bulletin board for the crew and passengers to read and keep informed as to what was happening in the rest of the world. People forget that we didn't always have photocopy machines and desktop computers... I used to listen to the above for copying plain text almost daily.

On modern ships there is a complete news department that gets the news from satellite and TV feeds, prints a small on board newspaper and distributes it daily to each cabin under the door. Complete with graphics and all the other frills. Not to mention on board TV and computer links.

While these stations were in operation I used to copy them daily when I wasn't tied up with other school activities. This helped me to get my speed to over 20 WPM in a hurry. I also learned a bunch of the characters that many CW ops don't know, don't use and don't care about. Things like left and right parenthesis, colon and semicolon just to mention a few. I'll have these on some files and would like for you to learn them and impress your family and friends. Of course, after this you may lose some of your friends.

Because of my learning to write down what I heard I still do that and I want you to learn it also. It comes in handy in more ways than you think. I used to win code copying contests at the Midland TX ham meets yearly at 35 and 40 WPM because you could not bring in a typewriter. Soupy Groves from Odessa and I used to battle it out each year for the first place certificate and another high speed op from Austin named Mark and I forget his last name. This was all over 40 years ago.

Writing Instrument

I want you to use a rolling writer or other type gel pen. You want something that has the least amount of friction across the paper. I buy packages of a dozen Uniball GEL STICK pens or Bic GEL ROLLER pens for around three bucks. They write smoothly and are very inexpensive for a quarter each from Staples Office Supply.

The reason for using a rolling writer pen over a ball point or pencil has to do with the physics of friction and resulting writing speed. Also you must not print. You MUST use cursive writing and I won't take no for an answer here. And here is a chance for you to work on your penmanship at the same time. I frequently see articles or letters in the newspaper about how the educational system in America no longer teaches this and I of course see it when I am in stores and other places and watch people write. Look online using your favorite search engine for penmanship, speedwriting, and cursive writing.

Later I will mention that at high speeds you need to reduce the length of descenders and ascenders of letters like g, q, l, and k. And also you might want to practice not crossing your t's and dotting your i's and come back later to do that. It will save time at very high speeds if you ever want to be able to do 30 WPM or so. FYI.

MP3 Player

I recommend that you buy a small Walkman type MP3 player if you can. I bought one at Target and Wal-Mart and have found them on sale from time to time for under 35 dollars. Fry's Electronics regularly has a GPX MP3 player for under 20 dollars. The Code Course will work well with any of them.

As of January 2007 there is the new rage in iPod MP3 players. The latest being the Suffle and it will hold the entire course and I have the files named so that you are able to go through them in order and a tone at the end of each lesson so that you will now when you have come to the end of the lesson.

Because I wanted to get over 10 hours of audio on a single disc I had to go to this format. Now if you already own a regular audio CD player you can find a computer program to convert the MP3 files back to the format that you need. The only problem is that it will take more than ten CDs to get the 100 plus files in that format.

Make sure that you have fresh batteries or do as I do and use NiMH rechargables. I know that they have saved me a ton of money and they are coming down in price at a rapid rate because of the digital camera craze.

I would like for you to have the portability of being able to take this code course with you and have access during the day if you get 5 or 10 minutes to practice. Every minute helps. And

later I will ask you to go to a busy place like a mall and practice an exercise or two to work on your concentration and block distractions.

I do not want you to use a computer for this course to play the CD. The computer is a distraction.

Headphones

OK, first of all. Your ears are very important and you only get issued one set per lifetime. So never never ever do you listen to Morse at loud volumes. Headphones come with documentation and you need to read it. Also make sure you have the volume at a minimum when you turn on the MP3 player. Make sure you or someone hasn't accidentally moved the volume control to a higher volume.

I dislike using speakers for copying Morse code. The sound from the speaker echos off of walls and solid objects and it will interfere with your hearing at high speeds. And the quality is an issue.

I like the new Sony **h.ear** light ear pieces that sell for 10 dollars at Wal-Mart. The model number is MDR-J10. I find them to be comfortable for long periods of time, but mileage may vary. And be very very careful as they are efficient and you will not need much volume. These are the earphones that you see in the photo.

I listen at the lowest volume possible. Here are the reasons for me. I want to be able to hear when I'm a hundred years old. Also at higher volumes you will generate a "thump" at the beginning of each element of a character. And the ear drum is like a bass drum. The harder you thump it the longer it will resonate, thus interfering with the next element of the code character and slowing you down.

And I'm sure there is a physiological effect that loud volumes will tire you much faster than low volumes. I have always protected my hearing from an early age in high school when I had a rocket that I built blow up when I bent over to pick it up after it did not launch for 15 minutes. I was very lucky. But my left ear did ring for two days after that event. I even left a KISS concert 5 minutes into it when I was working on my PhD at TAMU because the volume was so loud. I was almost at the back of the coliseum for the concert. My ears rang for an hour after just that short exposure period of high sound levels.

So protect your ears, please.

This CD can be used to experiment with different headphones and earphones. There is no thump on each of the elements of each character. So if you hear a thump or annoying pop then you need to check your volume and experiment by using another set of headphones or earphones.

Time and Place

There's not much I can tell you about this topic. It just seems to be going faster every year for all of us. You should start on this course today. If you don't, you will keep thinking of excuses to wait until tomorrow.

Find a quiet place away from the TV, family, and all the other distractions. Hopefully a desk or kitchen table where you can be comfortable and write easily. You just need about 15 minutes

to get started.

Try to set aside the same time period each day and do this almost every day. Don't do this when you are tired as the human mind doesn't work as well and you need every brain cell in top condition.

I taught and developed courses in both the university system and for a large computer company. One of the things that I learned about human attention span is that the average attention span for an adult is 20 minutes. After that the mind starts to wander and daydream. So learning the Morse code is going to teach you something about yourself and how well you concentrate. I find that CW operation and especially contest operation helps me to concentrate for longer periods of time. I play poker tournaments where I may have to sit and concentrate for several hours at a time before a break comes along. Look for me on ESPN starting in July in one of the shows. My experience with Morse seems to have helped.

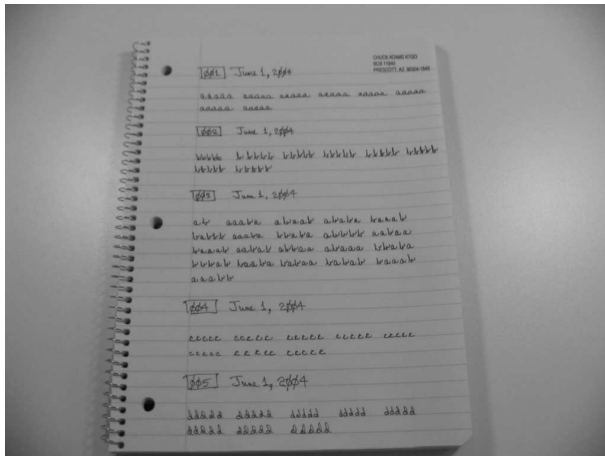
Your short term memory will be helped also because this required concentration helps exercise whatever part that is used for attention to the outside world. If you find that you drift and lose concentration then take a break, but do try to not use that as an excuse not to keep working.

Getting Started

Now we are ready to start the first lesson. I'm going through a lengthy discussion for this to get you started correctly. After that you keep on going until you get to the end.

Get setup with the player, earphones, pen, CD, and paper. OK. Open the notebook to the first or second clean page. You may want to put your name, call if any, etc. on the first page or inside cover in case the notebook gets misplaced so that it can be returned to you. Also make a backup copy of the CD if you have a CD burner on a computer. Make copies and give them to kids, relatives, friends, and even your enemies (drive them insane).

Now I have gone through this entire course myself and used a notebook as shown. What I do for each lesson or test is put the file number enclosed in a block on a line along with the current date. This way you can keep track and make sure that you aren't skipping too many days. You don't have to go to a new page each day or each lesson, but if you retake a test on the same page, then find a blank page to cover up the previous run so that you aren't tempted to compare while the test is in progress. Here is what my first page of my notebook looks like.



A Notebook Page.

The disc is setup at first to teach you two letters in two files and then there is a test that covers all the letters that you have learned up to that point. For example, 001 is for the letter **a** and 002 is for the letter **b**. File 003 is a test over **a** and **b**. Do not write the letters in caps. Always use lower case letters when copying CW as there is no need for capital letters and lower case is faster to write. Then files 004 and 005 are for **c** and **d** respectively with file 006 a test over the letters **a**, **b**, **c** and **d**. On the test files you will first hear the letters in the alphabet covered at that point then the letters in random order to test your retention.

The time required for each file or lesson is given in a table near the end of this manual. Start out trying the first 6 files in one session (about 20 minutes or so). Grade yourself on each test using the answer files on the disc. They are too long to include in print here, but if you feel like

killing trees then feel free to print them off and glue them into the notebook or whatever.

Morse code is a representation via sound of each character, numeral, punctuation and even some special combinations for procedure signs (pro-signs). Do not try to dissect them into individual components and most importantly do not count or visualize the individual elements of the character. This will only slow you down and you will develop habits that are very difficult to break.

On the Internet and in books you will see some people represent the sounds with dots and dashes. These individuals are not doing any one any favors by doing this. I'd bet you a dollar to a hole in a donut that these individuals can't do Morse at more than 35 WPM, otherwise they'd know better than to ruin the future training of other individuals. So don't you do it and I don't want to see you ever with flash cards. Use the CD.

How would you put down the sound of a jet engine, siren, steam locomotive (hope you have heard an actual locomotive in your life other than the big screen), fog horn, or other common sounds? No way. So why do the same thing with Morse?

So, for each character listen to the sound and then immediately write it down. Do this all the time. Don't think about it and if you do not recognize the character then skip it and get ready for the next one. For starters just leave an extra space on the page or put a small dot there for

grading purposes. You are training your neural networks in your mind to respond to the code sounds.

You will sometimes know what character is coming next. Do not ever write down a character before it is completed. I could have gotten nasty and made some files and inserted errors on purpose to break you of this habit, but I trust you to do right. The reason for tests with random letters is to make sure that you don't do this and to make sure that you instantly respond to and recognize characters rapidly.

Lesson One

Now open your notebook to your starting page and put 001 in a small block and the current date next to it. Get positioned to write and start the CD player on file 001. This is for the letter **a** (remember write, not print, in lower case). Every time you hear the sound combination for the letter **a** then immediately write it down and get ready for the next one. They may seem to come pretty fast but you'll get used to it. Concentrate on the sound you hear each time. Mentally, do not repeat it or convert it to what you think it is in sound. Don't try to verbalize the sound. Just hear it and then write down the letter. Make sure you try to remember it. There is an exaggerated quiet area between every 5 characters, so you may want to write the characters in groups of 5 letters with a space in between the groups. Write small and neatly and see how many you can get per line and still be able to read them.

After you finish file 001 then get ready for file 002 and do the same thing except this time it is for the letter **b** and write it down each time you hear it.

Hopefully your player doesn't get the two files too close in time, but it is OK to stop the player between files and setup for the next on on the page. Feel free to restart if necessary.

OK, after files 001 and 002 you should now have two letters memorized. But your mind probably needs some work so that is the purpose of file 003. Setup for file 003 and you will first hear **a** followed by **b**. Go ahead and write them down when you hear them. Then will come a sequence of the letters in random order. Copy the entire sequence and then stop the player.

Here is what you should have (don't peek at this until after you finish the test). The spacing is not critical and blanks do not count until we get to plain text.

```

ab
aaaba  abaab  ababa  baaab
babbb  aaaba  bbaba  abbbb
aabaa  baaab  aabab  abbaa
abaaa  bbaba  bbbab  baaba
babaa  babab  baaab  aaabb

```

Now mark your copy with a red pen for each letter that you missed. This test should be an easy one, but don't feel badly if you miss a few. Grade yourself. There are a total of 100 letters

not counting the first two. Thus if you missed 5 your grade is 95 per cent. Feel free to do this as many times as you like. You be the guide. Strive for perfection, but don't get too obsessive about this and wear yourself out. If you can tell the difference between a country and western song, classical music and rap, then you can learn the Morse code to any speed you want.

Lesson Two

What you want to do now is move on to files 004, 005 and 006. Do them the same way as you did for the previous files. Now this is the last time I'm going to do this for you, so don't get spoiled easily. Here is what you should get for 006, the test for a, b, c, and d.

```
abcd
bdbdb bdcac ccddd aabac
aabbd cdcba caddb cbacb
ccbca cbcad adada caacc
dadac badac bccbc cbcad
badad acbab cdada cbabc
```

How did you do? Good. There is no passing or failing grade here. You want to get to 100 per cent, but that will take time. Especially after you get to the entire alphabet and numbers. Be patient and don't try to bite off too much at one time. If you work on 6 to 9 files per day and do this daily you should have all the alphabet and the numbers in two weeks. Don't try to do them all in one day. That is the way they do things in

language schools where they do saturation. You don't need that here.

Review individual letter files regularly. After tests — check which letter or letters are giving you the most trouble and go back to the corresponding file and review it until you copy almost perfectly. Practice makes perfect.

We have now reached the point where there is not much more to tell you. You need to practice daily and do all that is on this CD. Keep a page in the back of your notebook for your test scores and dates. Take the tests multiple times. Each time will improve your ability to copy the Morse code. Do not feel badly if there are some files that seem to give you more trouble than others. Some are more challenging. Keep coming back to them until you get them mastered. You do not have to make 90 per cent or better every time. But it is nice when you reach that skill level and you will.

At some point I'd like for you to start over on the tests starting with 003. But on the second pass through them try to wait one or two characters before you start writing and practice on having one or two characters buffered in your mind. This takes some practice. It is not unlike taking notes in school where you had to copy behind what the instructor was saying or doing.

Advanced Exercises

Make at least one pass through the CD using your notebook and pen. Keep track of your

progress. Now it is possible that the speed required for handwriting may be too much for you. Hopefully this will not happen but it could. Just do what you can.

Now that you have made it through the course, let's start all over again. This time start with file 001 and start copying using a keyboard. I just spent 90 dollars for an electric daisy wheel typewriter just to do it myself. I can use a computer keyboard, but what challenge is that?

You want to train yourself to copy direct from sound to the key without any conscious thought. You may have heard the tales of expert Morse operators being able to copy to a mill (old name for the mechanical typewriter) and carry on a conversation at the same time. It comes only with years of practice.

If you are a typist, then there should be no limit to the speed at which you can copy.

Do the entire course several times on the keyboard until you can get excellent results. This may take several months to do, but don't stop in the middle for any reason. Work. Work. Work.

The contents of all the files are given in the **answers** subdirectory on the CD. Use these files to double check your work only after you have written down the code at least once. Try not to use these files as a handicap. You can copy the code and have an idea when an error has occurred. Build up your confidence with practice.

The SweepStakes file (121) contains contest ex-

changes for the November ARRL SweepStakes CW contest. Each line consists of a series of V's followed by a sequence number, a single letter, a call sign, a two digit number and the abbreviation for an ARRL section. This is good practice as the V's set your mind up for a speed and a tone then the characters start. You don't have to write down the V's as this represents where your call would go during the actual contest.

Wrap Up

Several things that you can do after you have thoroughly mastered the alphabet and all the numerals. You will note that throughout this course I have not mentioned one thing about code speed. That is secondary to learning the code. Practice and the speed will get there as the mind responds more rapidly to the Morse code sounds.

First thing that you might consider doing to supplement this code course is to download files from

www.arrl.org/w1aw/morse.html

These are the on the air sessions run by W1AW on a weekly basis. You can also check the ARRL web site for daily W1AW CW practice sessions. These you will know the speed of the transmissions and get an idea of just where your code speed is.

Also note the monthly code proficiency runs from W1AW and after you get your code speed at a comfortable level you can attempt to copy

these runs and get a very nice certificate from the ARRL. I collect these regularly at 40WPM, when they have the high speed run. Just a part of the hobby of copying high speed Morse code.

And lastly the most challenging thing of all. Go to the web site:

www.sk3bg.se/contest/

and look down the left hand side for Contest Software and click on it. Then look for the RUFZ by DL4MM link and click on it. This will locate a software package RUFZ3.2 that runs only under DOS, so you will need a WIN95/98 system that will run DOS only with an F8 bootup. Read all the info on this page about the program.

I challenge you to try this program. I have the highest score in North America and you can find it under Senior Male scores. But don't be intimidated by it. Just start out practicing and try it every day for 10 minutes. Then submit your highest score via the web as outlined on the web page. We need more new scores from North America. Let's see what you can do.

And I leave you with the words of Alexander Pope. "Not failure but low aim is crime". Give it your best shot and enjoy CW as a simple and efficient means of communication. It is as close as you can get for mind to mind communication when both parties are good at Morse code.

dit dit de K7QO

FILE	File Contents
001	a
002	b
003	a--b Test
004	c
005	d
006	a--d Test
007	e
008	f
009	a--f Test
010	g
011	h
012	a--h Test
013	i
014	j
015	a--j Test
016	k
017	l
018	a--l Test
019	m
020	n
021	a--n Test
022	o
023	p
024	a--p Test
025	q
026	r
027	a--r Test
028	s
029	t
030	a--t Test
031	u
032	v
033	a--v Test
034	w
035	x
036	a--x Test

FILE	File Contents
037	y
038	z
039	a--z Test
040	Two Letter Words
041	Two Letter Words
042	Three Letter Words
043	Three Letter Words
044	Three Letter Words
045	Four Letter Words
046	Mixed Words
047	1
048	2
049	1-2
050	3
051	1-3
052	4
053	1-4
054	5
055	1-5
056	6
057	1-6
058	7
059	1-7
060	8
061	1-8
062	9
063	1-9
064	0
065	1-0
066	cq de
067	QSO Beginning
068	Comma
069	Period
070	qth hr is
071	name hr is
072	rig hr is

FILE	File Contents
073	wx hr is
074	ur rst is
075	ant hr is
076	Question and Double Dash
077	QSO
078	QSO
079	QSO
080	QSO
081	QSO
082	QSO
083	Random Letters
084	Random Letters
085	Random Numbers
086	pi
087	Slant Sign /
088	Random Characters
089	Random Characters
090	Punctuation
091	kilometer
092	fort
093	fathom
094	logbook
095	mauna kea
096	watt
097	zenith
098	tugboat
099	teflon
100	quart
101	kakapo
102	mint
103	photon
104	summer
105	talc
106	putty
107	joule
108	hardness

FILE	File Contents
109	vanilla
110	tile
111	scissors
112	rake
113	alberta
114	cardboard
115	waterplant
116	hexagon
117	krypton
118	liveoak
119	integer
120	keck
121	SweepStakes Contest
122	abacus
123	almond
124	sonar
125	umbrella
126	bleach
127	eclipse
128	dew
129	liquid
130	sprat
131	sirius
132	solstice
133	barometer
134	free fall
135	waves
136	radar
137	hearing
138	light
139	english
140	sentences
141	verbs
142	adjectives
143	periods
144	questions

FILE	File Contents
145	commas
146	spelling
147	paragraph
148	outlines
149	alice

The following table is the time required for each MP3 file. The times are shown in the form of `mins:secs` and are shown as close as possible to the actual audio time in the file. Some players, if they show the times, may be off a second or two. You may need these only if you are on a time schedule, such as a break or lunch at work.

	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
300		12:32	17:57	18:07	17:00	16:26	17:00	16:19	15:05	17:16
310	15:36	16:58	11:24	13:45	16:23	13:48	15:42	11:56	13:09	17:18
320	16:36	11:29	12:46	13:36	13:57	13:57	9:39	14:44	14:24	11:58
330	13:57	11:48	8:55	11:52	12:11	11:22	15:04	13:30	11:55	11:48
340	12:14	9:33	12:11	9:49	8:16	12:35	9:59	12:06	12:03	12:04
350	12:44	11:18	11:33	11:54	8:47	13:04	10:55	5:08	11:26	12:00
360	12:05	9:29	11:31	10:56	6:59	9:49	9:10	10:17	10:41	10:06
370	10:30	11:17	10:33	11:03	11:06	9:11	12:28	11:51	10:03	7:58
380	6:15	7:21	6:56	9:34	12:10	11:42	11:08	10:05	11:48	11:23
390	11:00	11:22	10:35	11:07	9:09	11:13	8:00	11:20	10:59	10:21
400	12:11	8:44	9:32	10:06	9:26	9:38	8:14	10:09	9:16	9:05
410	6:55	9:00	8:44	9:28	7:11	8:15	9:11	8:36	6:07	7:21
420	9:05	8:34	7:32	10:46	9:55	9:48	10:03	9:49	9:18	10:02
430	9:47	8:30	8:47	8:50	8:51	9:08	10:10	9:07	8:47	9:33
440	6:31	8:50	7:57	7:23	10:22	9:14	10:09	9:27	9:53	9:35
450	9:46	11:12	10:30	10:18	8:36	9:59	10:04	10:02	10:00	9:44
460	8:30	8:47	7:43	8:30	9:07	6:45	7:45	7:55	7:52	7:46
470	9:08	9:53	9:47	9:24	9:01	10:51	10:24	7:40	6:40	6:18
480	6:23	7:50	9:00	6:33	9:29	7:59	7:59	8:56	9:54	10:07
490	7:23	8:02	7:42	9:52	7:23	9:31	9:39	9:27	9:36	9:38
500	9:34	9:56	9:19	9:49	8:32	10:13	9:28	10:38	9:13	8:53
510	7:05	9:44	9:45	9:36	6:41					

References

1. The American Radio Relay League, Inc., "The ARRL Handbook". Connecticut, The ARRL. 1995 and later.
2. The American Radio Relay League, Inc., web page, <http://www.arrl.org/>