It is possible to pass the technician's license exam by just memorizing the questions and answers but some of you may want to or need to supplement your memorization with a little understanding. The following explains some of the "why" without going all the way to being a textbook. When you get a radio and get on the air, you'll have plenty of time and opportunity to understand why.

The FCC requires only that you pass the exam to get a license – they don't require that you understand *everything*. Indeed, you can miss 9 answers out of 35 and still pass. For example, you could miss every computational question or all of the safety questions and they'll still grant you a license. The FCC and the ham radio community wants you to have read all 429 questions and answers before you get on the air, but they certainly don't expect you to remember it all – that's what books are for!

Passing the exam shouldn't be the end of your ham radio education. We provide two follow-on classes to make sure you get a good start on the rest of your education and we really want you to get on the air to continue learning by doing and asking questions. The ham community is there to help you but first you have to get your license, get a radio, learn to use it and get on the air!

Here are the answers to the questions we get asked most often:

What is CW?

CW stands for ***C****ontinuous* ***W****ave*, but for the purpose of the Tech exam it simply means **Morse code**.

The FCC has rules that limit *where voice* communication may be used to allow for CW communications without interference from voice stations. The rules state that only CW may be used on the first .1 MHz of the 2-meter and 6-meter bands (**144.0 MHz to 144.1 MHz, and 50.0 MHz to 50.1MHz**).

What is CW?
Another name for a Morse code transmission

What method of call sign identification is required for a station transmitting phone signals?
Send the call sign using a CW or phone emission

Which of the following VHF/UHF band segments are limited to CW only?
50.0 MHz to 50.1 MHz and 144.0 MHz to 144.1 MHz

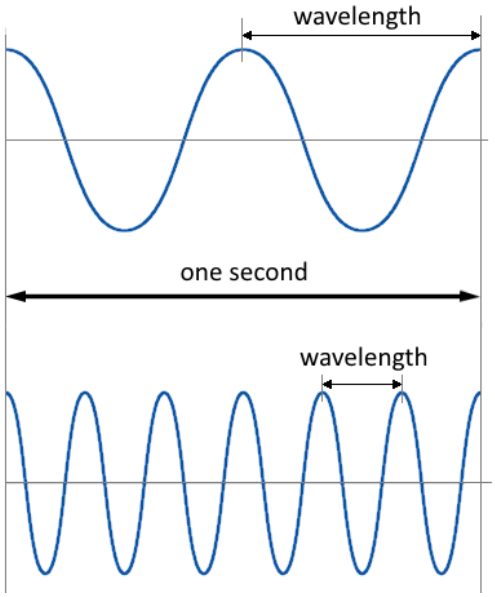
What antenna polarization is normally used for long-distance CW and SSB contacts on the VHF and UHF bands?
Horizontal

What is the function of the SSB/CW-FM switch on a VHF power amplifier? Set the amplifier for proper operation in the selected mode

Which of the following types of signal has the narrowest bandwidth? CW

What is the approximate bandwidth required to transmit a CW signal?
150 Hz

What mode of transmission is commonly used by amateur radio satellites?
-SSB
-FM
-CW/data
All these choices are correct



Frequency vs. Wavelength

How can I remember all those frequencies and wavelengths? **There is a way that you can compute the answer rather than memorizing, because there's a relationship between frequency and wavelength.**

If you could see a radio wave it would look something like a wave traveling through water with a series of peaks and troughs.

The **length** of any wave is the **distance** it travels as it makes one cycle from any starting point up through its highest peak, down to its lowest point and back up to the starting point.
For radio waves, a **wavelength** is the distance the wave travels through one cycle of positive and negative voltage and north-south magnetic fields.

The **frequency** of any wave is defined as the number of cycles the wave makes during **one second**. In the figure to the right the bottom wave has a higher frequency than the wave above it. It goes through six cycles in the same length of time that the top wave goes through two.

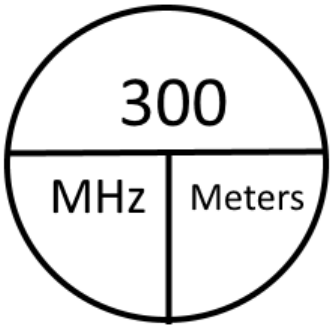
Wavelength gets shorter as the frequency increases.

Calculating the relationship between radio frequencies and wavelengths is pretty easy:

- Radio travels at the speed of light or **300,000,000 meters per second**
- **Wavelength** is equal to the speed of light **divided** by **frequency**
- **Frequency** is equal to the speed of light **divided** by **wavelength**

Frequency is expressed in *cycles per second*. One cycle/second is defined as one **Hertz** (**Hz**). One million Hertz is one **Megahertz** (**MHz**). So, we have these relationships between frequency and wavelength:

$$\frac{\textbf{300 } \textbf{\textit{million}} \textbf{ meters/second}}{\textbf{frequency in } \textbf{\textit{millions}} \textbf{ of cycles/second}} = \frac{\textbf{300 meters/second}}{\textbf{frequency in cycles/second}} = \textbf{Wavelength in meters}$$



Was that too much math and science? Well, you can just memorize the frequencies and wavelengths and still pass the exam. Or decide to miss those but make sure you learn the rest. It's your choice.
You can use the following diagram to figure out the math instead of learning a formula: Cover up the thing they're asking you for (MHz or Meters), and divide 300 by the thing they give you (meters or MHz):

To get **frequency** (*in MHz*) divide 300 by **wavelength** (*in meters*)

To get **wavelength** (*in meters*)**,** divide 300 by **frequency** (*in MHz*)

In the following questions and answers, of which you might get just one on the exam, the answer is ***approximately*** 300 divided by the number in the question.

Which frequency is in the 6 meter amateur band?
52.525 MHz

Which amateur band includes 146.52 MHz?
2 meters

What is the national calling frequency for FM simplex operations in the 2 meter band?
146.520 MHz

What is the relationship between wavelength and frequency?
Wavelength gets shorter as frequency increases

What is the formula for converting frequency to approximate wavelength in meters? Wavelength in meters equals 300 divided by frequency in megahertz

In addition to frequency, which of the following is used to identify amateur radio bands?
The approximate wavelength in meters

What is the approximate velocity of a radio wave in free space? 300,000,000 meters per second

Which of the following increases the resonant frequency of a dipole antenna? Shortening it

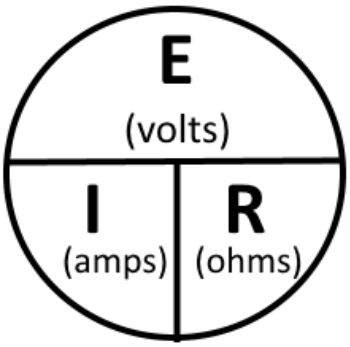
Ohm's Law

Ohm's Law defines the relationship between electrical **current, voltage, and resistance.**

I is the **Intensity** of the electrical Current measured in **Amperes** (or Amps)
E is the **E**lectromotive Force or **Voltage**, measured in **Volts**
R is **Resistance**, measured in **Ohms**

Current = Volts ÷ Ohms
I = E ÷ R

The diagram to the right is a good memory aid. Think of Lake Erie except we'll spell it "**ERI**": Start at the top and write the letters **E R I** -- it doesn't matter if you write them clockwise or counter-clockwise. If an exam question gives you two of those values and asks you to provide the third you can use this diagram to figure out whether to multiply or divide to get the answer.



If they ask for **R**, put your finger over **R** and you're left with **E** "over" **I**, so **E** divided by **I**.

If they ask for **I**, put your finger over **I** and you're left with **E** "over" **R**, so **E** divided by **R**.

If they ask for **E**, cover up **E** and multiply **I** times **R** (because they're next to each other).

You can write the Ohm's Law diagram on the back or margin of your *answer sheet*, (**BUT NEVER ON YOUR TEST BOOKLET**), so you don't have to remember it very long. We keep it in front of you for most of the class, and take it down just before we hand out the test booklets and answer sheets.

How can you remember the units that go with E, R and I? Think of the ***"Voice Of America" transmitting signals across Lake ERI***. V O A = **V**olts **O**hms **A**mps, and they go with **E R I**.

You can use the "**E R I**" diagram to answer the following: (one of these questions will be on your exam).

What formula is used to calculate current in a circuit? I = E / R

What formula is used to calculate voltage in a circuit? E= I x R

What formula is used to calculate resistance in a circuit? R = E / I

What is the resistance of a circuit in which a current of 3 amperes flows when connected to 90 volts?
30 ohms

What is the resistance of a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?
8 ohms

What is the resistance of a circuit that draws 4 amperes from a 12-volt source?
3 ohms

What is the current in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?
1.5 amperes

What is the current through a 100-ohm resistor connected across 200 volts?
2 amperes

What is the current through a 24-ohm resistor connected across 240 volts?
10 amperes

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?
1 volt

What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?
10 volts

What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?
20 volts

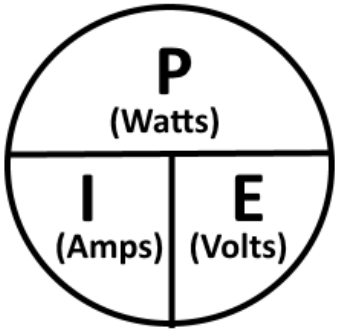
Power

Power calculated as **Current** times **Voltage** and it's unit is the **Watt.**

It's easy to remember that formula if you think of the diagram to the right: "It's as easy as PIE."

Power (watts) **= Current** (amps) x **Voltage** (volts)

P = I x **E**



The formula you use to calculate **Power** applies to the following exam questions:

What is the formula used to calculate electrical power (P) in a DC circuit? P = E × I

How much power is delivered by a voltage of 13.8 volts DC and a current of 10 amperes?
138 watts

How much power is delivered by a voltage of 12 volts DC and a current of 2.5 amperes?
30 watts

How much current is required to deliver 120 watts at a voltage of 12 volts DC?
10 amperes

Decibels

A **decibel** (dB) is a *measurement of change* as compared to some given base level. In radio it measures the change in **power** in terms of watts. Every time power is doubled, the decibel level goes up 3 dB. Every time power is cut in half, the decibel level does down 3dB. There are only three possible questions on Decibels, and here they are:

Which decibel value most closely represents a power increase from 5 watts to 10 watts?
3 dB

Which decibel value most closely represents a power decrease from 12 watts to 3 watts?

-6 dB

Which decibel value represents a power increase from 20 watts to 200 watts?

10 dB

Metric Units

Mega, kilo, milli *what???* Just as a refresher here's a chart of all the metric units you *could* encounter in the exam and how to do those pesky conversions. *Important Note:* the symbol for **mega** (meaning one million) is an upper case "M"; the symbol for **milli** (meaning one-thousandth) is a lower case "m".

Metric Prefix	Symbol	Multiplication Factor
giga	G	1,000,000,000
mega	M	1,000,000
kilo	k	1,000
centi	c	1/100 (or .01)
milli	m	1/1,000 (or .001)
micro	μ	1/1,000,000 (or .000001)
pico	ρ	1/1,000,000,000,000 (or .000000000001)

One **gigahertz** (GHz) is one billion (1,000,000,000) times bigger than a **Hertz**
One **megahertz** (MHz) is one million (1,000,000) times bigger than a **Hertz**
One **kilohertz** (kHz) is one thousand (1,000) times bigger than a **Hertz**

One **milliwatt** (mA) is one thousand times smaller than one **Watt**
One **microampere** (μA) is one million times smaller than one **Amp**
One **picofarad** (ρF) is one million times smaller than a microfarad (mF) and one trillion times smaller than one **Farad**

***Exam Questions* that use metric prefixes:**

How many milliamperes is 1.5 amperes? 1500 milliamperes

Which is equal to 1,500,000 hertz? 1500 kHz

Which is equal to one kilovolt? One thousand volts

Which is equal to one microvolt?
One one-millionth of a volt

Which is equal to 500 milliwatts?
0.5 watts

Which is equal to 3000 milliamperes?
3 amperes

Which is equal to 3.525 MHz? 3525 kHz

Which is equal to 1,000,000 picofarads?
1 microfarad

Transistor Questions

What are the names of the electrodes of a bipolar junction transistor?
Emitter, base, collector

Which of the following can provide power gain?
Transistor

Which of these components can be used as an electronic switch?
Transistor

Which of the following components can consist of three regions of semiconductor material?
Transistor

What type of transistor has a gate, drain, and source? Field-effect

What does the abbreviation FET stand for? Field Effect Transistor

Why do most solid-state transmitters reduce output power as SWR increases beyond a certain level?
To protect the output amplifier transistors

What is component 2 in figure T1?

Transistor

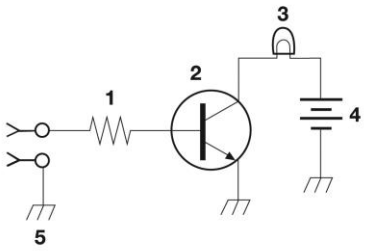


Figure T-1