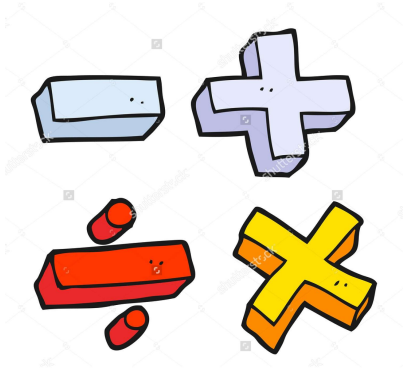
Quick Math Review

Technician Class

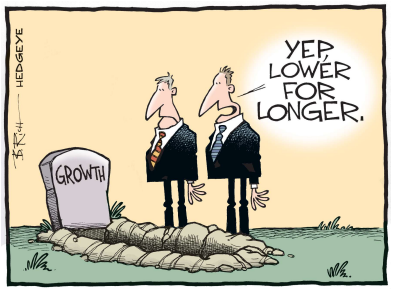
Jim Grover



At the end of the Technician Class licensing course but before the element 2 exam you might want to review the math related questions.

Longer is Lower (λ α 1/f)

- Band designations are approximate
- 2 meters is 144.0 MHz to 148 MHz
  - λ = 300/144.0 = $2.0\overline{83}$ meters
  - λ = 300/148.0 = $2.\overline{027}$
- Or shorter is higher.



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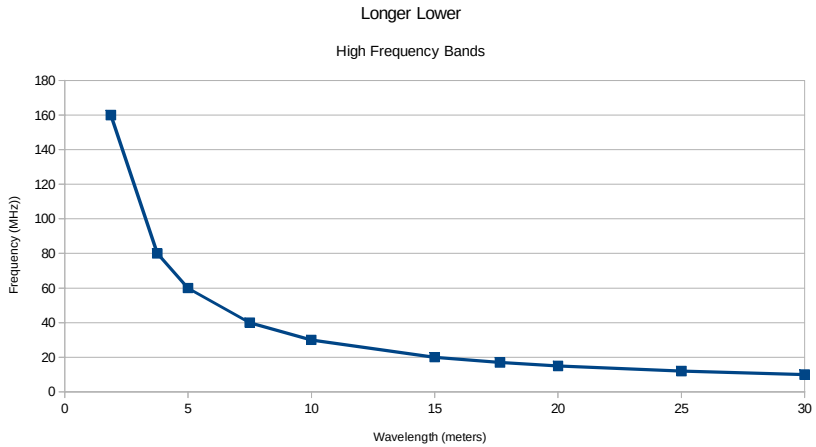
Remember that wave length and frequency are inversely related. That is to say that wavelength is poportional to 1 over the frequency. Or some people say “Longer (wavelength) is Lower (frequency).”

$\lambda = \frac{300}{f}$

Consider the 2-meter band that runs from 144.0 MHz and 148.0 MHz. Using the $\lambda = \frac{300}{f}$, where λ is in meters and f is in MHz. Therefore the wavelength is 300/144.0 to 300/148.0 or $2.0\overline{83}$ to $2.\overline{027}$ meters. That is approximately 2 meters.

Longer is Lower (λ α 1/f)

- 2 meter Band (f = 300/2 ≈ 150 MHz)
- 30 meter Band (f = 300/30 ≈ 10 MHz)



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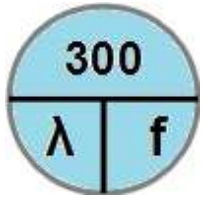
In the above graph frequency is the independent variable and wavelength is the dependent variable. Note as the wavelength goes from 2 meters to 30 meters, the frequency shifts from 150 MHz down to 10 MHz in a non-linear but continuous manner. This is cause reciprocal relationship of frequency and wavelength.

Wavelength – Frequency Calculation

Which 70 cm frequency is authorized to a Technician Class license holder operating in ITU Region 2?

A. 53.350 MHz
B. 146.520 MHz
C. 443.350 MHz
D. 222.520 MHz

Convert 70 cm to 0.7 meters and then to frequency and *f* = 300/0.7 = 428.57 MHz and C is the correct answer.



λ in meters
f in MHz

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Using the circle with 300 over the wavelength (λ) in meters and frequency (f) in MHz, we can calculate one given the other.

To answer the question we must conver 70 cm to meters. Since there are 100 cm per meter 70 cm is 0.7 meters. We want frequency because all the answers are given in MHz, so 300/0.7 = 428.57 MHz. Therefore C or 442.350 MHz is the correct answer.

E = I x R

- All correct answers are exact and not approximations
  - Eagle flies over the Indian and rabbit.

- Given voltage (E) and resistance (R) find current (I)T5D07 page 161.
  - E = 120 volts
  - R = 80 ohms
  - I = 120/80 = 1.5 amps

I = E ÷ R
Finding Current

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Ohm's Law is E = I x R or the "**E**agle flies over the **I**ndian and the **R**abbit."

Suppose we want to find the current, I, given the voltage, E, and the resistance, R. Cover over the I or Indian and we see I is E over R. In the example E is 120 volts and R is 80 ohms. Therefore I = 120 over 80 or 1.5 amps.

E = I x R

- Given current (I) and Resistance (R) find voltage (E) T5D10 page 160.
  - I = 0.5 amps
  - R = 2 ohms
  - E = 0.5 x 2 = 1 volt

E = I × R
Finding Voltage

- Given current (I) and voltage (E) find resistance (R) T5D04 page 162.
  - I = 4 amps
  - E = 12 volts
  - R =3 ohms

R = E ÷ I
Finding Resistance

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Or given current, I, and resistance, R, find voltage E. We want to find E so cover it with your finger and we see I x R yields the answer. In the example 0.5 amps time 2 ohms yiels 0.5 x 2 = 1 volt.

In a simular manner given the current, I, and the volate, E, find R. Cover over R with your finger and R is E over I. In the example I is 4 amps and E is 12 volts, thus the resistamce, R, is 12 over 4 which is equal to 3 ohms.

P = I x E

- Given current (I) and voltage (E) calculate power (P) T5C10 on page 159.
  - E = 12 volts
  - I = 2.5 amps
  - P = 12 x 2.5 = 30 watts

P = I × E
Finding Power

- Given power (P) and voltage(E) calculate current (I) T5C11 on page 160.
  - P = 120 watts
  - E = 12 volts
  - I = 120/12 = 10 amps

I = P ÷ E
Finding Amperes

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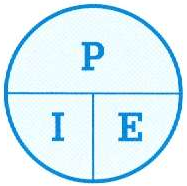
From “I like PIE”, we form the circle with P over I times E. Given the current, I, and the voltage, E, calculate the power. Cover over the P and I time E is left. In the example E is 12 volts and I is 2.5 amps. Calculate the power P in watts. We see 12 x 2.5 is 30 watts.

In a similar manner, given power, P, and the voltage, E, we can calculate the current, I. Now cover over I and we see I is P over E or 120 watts over 12 volts yielding 10 amps.

P = I x E

- All correct answers are exact and not approximations



- Given power (P) and current (I) calculate voltage (E).
  - Wow, none on test...
  - P = 30 watts
  - I = 2.5 amps
  - E = 12 volts

E = P ÷ I
Finding Voltage

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Note all the answers are exact and not approximate. Joule's Electrical Law is P = I x E.

Lets work a problem where the power, P, and the current, I, are given and the voltage is to be determined. Actually there is not a problem of this exact type on element 2 pool of questions. Consider P is 30 watts and I is 2.5 amps. Cover over E and we see P over I is 30 over 2.5 or 12 volts.

Decibel Table

- Increase in power use positive sign
- Decrease in power ($P_{out}/P_{in} < 1$) add negative sign

dB	Power Change
3 dB	2× Power change
6 dB	4× Power change
9 dB	8× Power change
10 dB	10× Power change
20 dB	100× Power change
30 dB	1000× Power change
40 dB	10,000× Power change

There are two ways to deal with decibels or dB. One is the tabular approach which is shown on this slide. Note a doubling is power ratio adds 3 dB. As an example 8 times the power ratio is 2 x 2 x 2 the power ratio or 3 dB + 3 dB + 3 dB = 9 dB.

A decrease in the power ratio below 1 requires us to add a minus sign. As an example 1/8 the power ratio is ½ x ½ x ½ the answer in dB is -3 + -3 + -3 or -9 dB.

$$dB = 10 \log_{10} P_{out}/P_{in}$$

- $10^{0.3} \approx 2$, $10^{0.6} \approx 4$, $10^{1} = 10$
- Given power out (P_{out}) and power in (P_{in}) calculate power increase in dB T5B09 on page 168.
  - Pout = 10 watts
  - Pin = 5 watts
  - dB = 10 $\log_{10}$ 10/5
    = 10 $\log_{10}$ 2
    = 10 x 0.3
    = 3 dB

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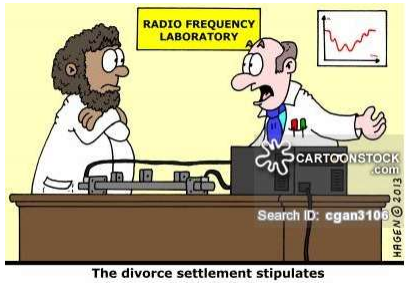
Or you can use a calculator and the logarithmic and anti-logarithmic functions.

First use the anti-logarithmic relationship for given dB find the power ratio. Now consider 3 dB, 6 dB and 10 dB or $10^{3/10} = 10^{0.3} \approx 2.0$, $10^{6/10} = 10^{0.6} \approx 4.0$, and $10^{10/10} = 10^{1} = 10.0$.

Next given the power out and power in calculate the power gain in decibels or dB. In the example Pout is 10 watts and power in is 5 watts for a power

$$dB = 10 \text{ Log}_{10} P_{out}/P_{in}$$

- -3 dB is equivalent to what power ratio?
  - $10^{-3/10} = 10^{-0.3} \approx ½$ or 0.5
- Given power out (P_{out}) and power in (P_{in}) calculate power increase in dB T5B10 on page 168.
  - Pout = 3 watts
  - Pin = 12 watts
  - dB = 10 Log_{10} 3/12
    = 10 Log_{10} ¼
    = 10 x -0.6
    = -6 dB



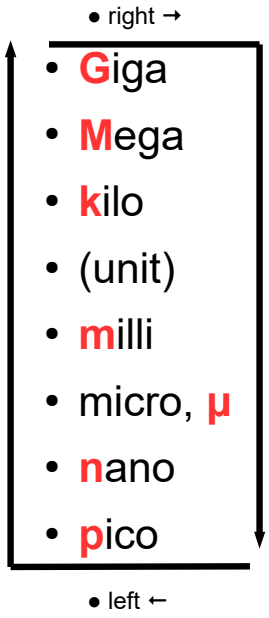
The divorce settlement stipulates she gets -3 dB of all the assets...

Lets first work an anti-logarithm problem. Minus three decibels is equivalent to what power ratio? First raise 10 to the power of -3/10 or 0.3. Use a calculator to find $10^{-0.3}$ or 0.5.

Now work the other way an do a logarithm problem. Given power out of 3 watts and power in of 12 watts we have $10 \log_{10} 3/12 = 10 \log_{10} 0.25 = -6$ dB

SI Prefixes

- Use factor of 3 exponent for engineering notation or
  - 3 x 3 = 9 for Giga,
  - 3 x 2 = 6 for Mega,
  - 3 x 1 = 3 for kilo,
  - 3 x 0 = 0 for units,
  - 3 x -1 = -3 for milli,
  - 3 x -2 = -6 for micro,
  - 3 x -3 = -9 for nano, and
  - 3 x -4 = -12 for pico.



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Engineering notation is used through out radio science and engineering. With engineering notation the exponent in exponential notation is always a factor of 3. Such as 10^{9} for Giga, 10^{6} for Mega, 10^{3} for kilo, 10^{0} for units, 10^{-3} for milli, 10^{-6} for micro(), 10^{-9} for nano and 10^{-12} for pico.

Each successive step up the ladder is multiplying the lower rung by 1,000 to get to the next rung. 1,000 pico is 1 namo, 1,000 nano is 1 micro, 1,000 micro is 1 milli, 1,000 milli is the units position, 1,000 units is

SI Prefixes

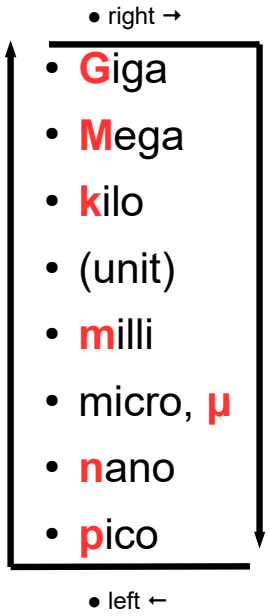
- T5B13 If a frequency readout shows a reading of 2425 **MHz,** what frequency is that in **GHz**?
- From MHz to GHz must move decimal point to left and go up chart
- 2425 MHz → 2.425 GHz

A) 0.002425 GHz

B) 24.25 GHz

C) 2.425 GHz

D) 2425 GHz



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Lets work a problem using engineering notation. The problem as stated asks us to convert 2425 MHz to GHz. We are moving up the ladder so we are moving the decimal point to the left. But we must change the prefix from Mega to Giga to have the magnitude of the frequency stay the same.

So lets start with 2425 MHz and move the decimal point three places to the left or 2.425 and change the prefix from Mega to Giga or 2.425 GHz.

Calculator Rules

- A calculator with the memory erased and formulas cleared is allowed.
- You may **NOT** bring any written notes or calculations into the exam session.
- Slide rules and logarithmic tables are acceptable, as long as they're free of notes and formulas.

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As a reminder a calculator with memory must be erased before it can be used on the element 3 exam. The best things is a calculator without memory.

You are not allowed to bring written notes or calculations into the exam session. The FCC felt that this would be begging some people to sneak in the answers to the excam questions. Therefore all VECs disallow notes and calculations.

You can bring a calculator, slide rule or logarithm

Calculator Rules

- Cell phone must be silenced or turned off during the exam session and the phones' calculator function may not be used.
- In addition, iPhones, iPads, Androids, smartphones, Blackberry devices and all similar electronic devices with a calculator capability, may **NOT** be used.

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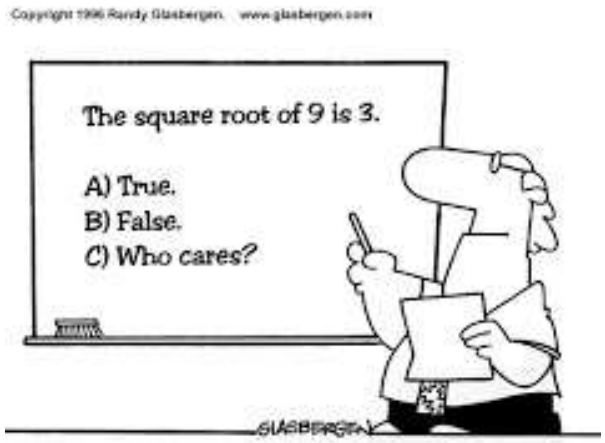
Cell phones must be silenced during the exam.

Note your cell phone, tablet or laptop has memory which cannot be cared or the device will not function. Therefore these items are not allowed to be used during the exam. All wireless device cannot be used during the test in that it begs some people to use these devices to communcate with other to cheat during the exam.

Questions?



Many students actually look forward to Mr. Atwadder's math tests.

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Are there any questions.