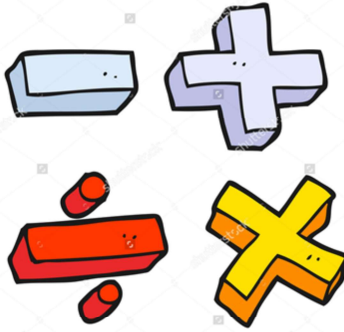# Quick Math Review

Technician Class

Jim Grover

This is a quick review of the math related question on the Technician class license examination.

Longer is Lower ($\lambda \propto 1/f$)

- Band designations are approximate
- 2 meters is 144.0 MHz to 148 MHz
  - $\lambda = 300/144.0 = 2.0833$ meters
  - $\lambda = 300/148.0 = 2.027$
- Or shorter is higher.

YEP, LOWER FOR LONGER.

GROWTH

2

Lets start with the inverse relationship of wavelength and frequency. That is to say λ is inversely proportional to f (or proportional to 1/f). Thus a longer wavelength is a lower frequency. And a shorter wavelength is a higher frequency.

Remember the band wavelength is most often rounded to the next nearest whole number. As an example we call it the two-meter band, but the actual wavelengths are slightly larger than 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)

Longer Lower

High Frequency Bands
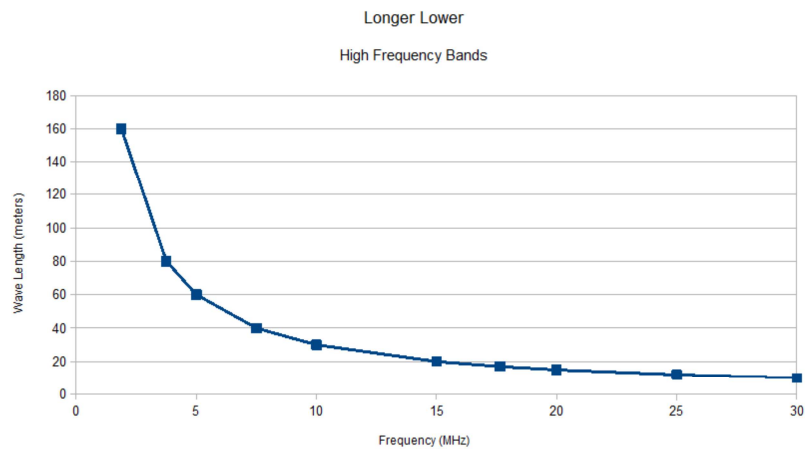
To see this longer is lower relationship look at the graph above. The 2 meter band is around 150 MHz and the 30-meter band is around 10 MHz.

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 (100 cm to 1 meter) and then to frequency and $f =$ 300/0.7 = 428.57 MHz and C is the correct answer.

300

λ | f
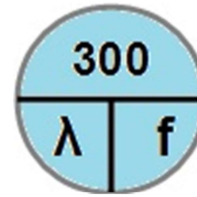
λ in meters
f in MHz

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We are given a wavelength and want a related frequency. Using the magic circle, we cover up the frequency and see that we should divide 300 by λ or the wavelength.

See the slide for the solution.

E = I x R

- All correct answers are exact and not approximations
  - Eagle flies over the Indian and Rabbit.
- Find current (I), given voltage (E) and resistance (R).
  - 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. When transferred to the magic circle we get the circle shown above. If you cant remember which symbol goes where, remember "The eagle flies over the indian and the rabbit."

There are three type of questions that could be placed on the examination. Only two of the three are on the exam.

One style would be given the voltage and resistance, calculate the current. Use the magic circle and cover up the current for which we us I. The result is I = E/R.

See the slide for the solution.

E = I x R

- Find voltage (E) given current (I) and Resistance (R).
  - I = 0.5 amps
  - R = 2 ohms
  - E = 0.5 x 2 = 1 volt

E = I × R
Finding Voltage

- Find resistance (R) given current (I) and voltage (E)
  - I = 4 amps
  - V = 12 volts
  - R =3 ohms

R = E ÷ I
Finding Resistance

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A second style would be given current and resistance, find the voltage. Using the magic circle cover the voltage symbol E. Now we se we need to multiple the current by the resistance.

See the top half of the slide for an example.

A third style would be given voltage and current, find the resistance. Using the magic circle cover the resistance symbol R. Now we see we need to divide the voltage by the current.

See the bottom half of the slide for an example.

P = I x E

- Calculate power (P) given current (I) and voltage (E).
  - E = 12 volts
  - I = 2.5 amps
  - P = 12 x 2.5 = 30 watts
- Calculate current (I) given power (P) and voltage(E).
  - P = 120 watts
  - E = 12 volts
  - I = 120/12 = 10 amps

The power law is P = I x E. Again you can use the magic circle with P, I and E in the circle. P is over the I and the E If you can't remember what symbol goes where remember, " I like PIE." P goes on the top with I and E across the bottom.

Again there are three styles of questions. Just cover one of the three symbols, the unknown, and use the exposed symbol with the either one times the other or one over the other.

The top half of the slide shows a given I and E, find P. The bottom half shows a given P and E find I.

P = I x E

- All correct answers are exact and not approximations
- Easy as PIE.
- Calculate current (V) given power (P) and current (I).
  - Wow, none on test...
  - P = 30 watts
  - I = 2.5 amps
  - V = 12 volts

E = P ÷ I
Finding Voltage

Remember, unlike the frequency and band relationships which are approximate, Ohm's Law and the Power Law are exact relationships.

The mnemonic "I like PIE" or "Easy as PIE" indicate where the symbols should be placed in the magic circle.

There is a third style of problem where you want to calculate voltage and are given power and current. The bottom half of the slide gives an example.

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

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For decibel you can remember a few entries from the above table or use a scientific calculator. This slide shows the table.

If there is an increase in power, such as a power amplified, the result is positive. For a reduction or loss the result is negative.

$$dB = 10 \, Log_{10} \, P_{out}/P_{in}$$

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

The equation method is shown at the top of the slide. If you always use the power out over the power in the magnitude and sign will be correct. On the calculator use the kep marked Log and not Ln. Also don't forget to multiply by 10.

Assume the power into the amplifier is 5 watts and the power out is 10 watts. If you plug and chug you get the result of 3.03 which is very close to the given answer of 3 dB.

$$dB = 10 \, Log_{10} \, P_{out}/P_{in}$$

- $10^{-0.3} \approx$ ½ or 0.5
- Given power out (P_{out}) and power in (P_{in}) calculate power increase in.
  - Pout = 3 watts
  - Pin = 12 watts
  - dB = 10 Log_{10} 3/12 = 10 Log_{10} = 10 x -0.6 = -6 dB

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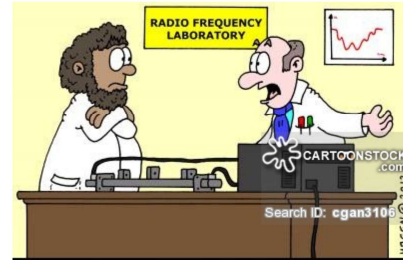
The divorce settlement stipulates she gets -3 dB of all the assets...

11

Now consider a power loss situation such as the power into a transmission lign is 12 watts and the power out is only 3 watts.

If you plug these numbers into the formula and chug to the answer, you can see from the slide you get the correct negative result.

SI Prefixes

- 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

- **G**iga
- **M**ega
- **k**ilo
- (unit)
- **m**illi
- micro, **μ**
- **n**ano
- **p**ico

● left ←
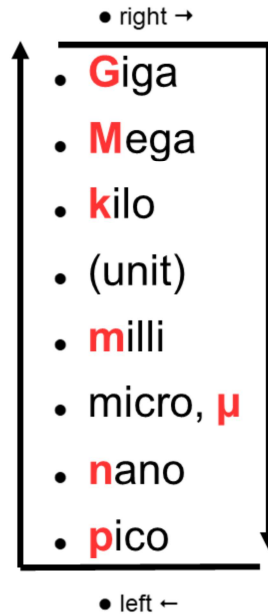
12

Radio science uses the System International of SI units. There are standard prefixes that are used with these units. To go from top to bottom on the chart you move the decimal point to the right three places adding trailing zero if needed. Or if you are moving from bottom to top you move the decimal point to the left three places and add leading zeros if needed.

In the example one is going from MHz to GHz or up the chart on position. Move the decimal-point to the left three places. Not no leading zeros are required.

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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You are allowed to use a calculator on the exam. If the calculator has memory you must demonstrate that the memory has been erased.

You may not bring written notes of calculations (not calculators) into the exam.

You can go "old school" and bring slide rules and logarithm tables to the exam. The tables may not have notes or formulas written in them.

Calculator Rules

- Cell phone must be silenced or turned off during the exam.

- In addition, iPhones, iPads, Androids, smartphones, Blackberry devices and all similar electronic devices with a calculator capability, may **NOT** be used.
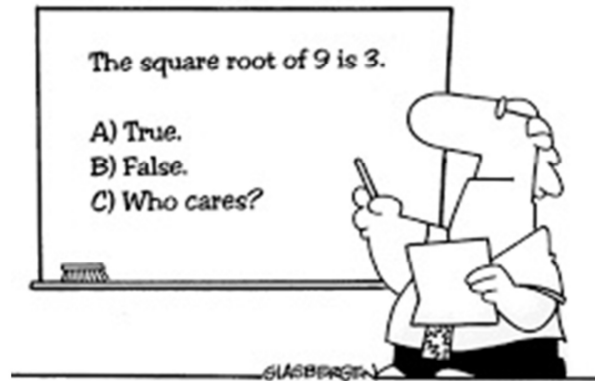
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You may not use a cell phone during the exam. Turn the phone off, don't just silence the ringer.

Computers and cell phones may not be used for calculation. You can't use the cool cell phone calculator app.

Questions?

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

Any questions?