

Lecture 0: 10 Calculator- Free Math Rules to Live By

1. Knowing some of the basic root and natural log values is a good thing.

$$2^5 = 1.4$$

$$3^5 = 1.7$$

$\ln 0$ doesn't exist

$$\ln 1 = 0$$

$$\ln 2 = .7$$

$$\ln 2.7 = 1$$

2. Logarithmic identities are your friend. Why? Because $\log(a/b) = \log a - \log b$ and $\ln(ab) = \ln a + \ln b$.

3. Knowing a few trig values won't kill you. This is all you need

$\sin 0^\circ = \cos 90^\circ = 0$, $\sin 30^\circ = \cos 60^\circ = 0.5$, $\sin 45^\circ = \cos 45^\circ = 0.7$, $\sin 60^\circ = \cos 30^\circ = 0.86$, $\sin 90^\circ = \cos 0^\circ = 1$
(do you see the square root pattern?)

4. Exponent math abounds in physical science tests. MOST calculations involve exponents. You should be happy because exponents exist to make arithmetic easier. Why? They turn powers into multiplications and multiplications into additions. For example, $(10^{-3} \times 10^{-7})^{0.5} = 10^{-5}$.

5. Estimates are excellent. You should get to where you don't need to use a pencil to do your calculations—it wastes huge amounts of time. So Avogadro's number is 1×10^{24} , pi = 3, a Faraday is 1×10^5 . And every other number in a calculation should be simplified little bits at a time. If you see a 2.3 and a 4.7 in the denominator, divide by 10. If you see a 6.4 in the numerator and a 5.9 in the denominator, they cancel out. Trust me.

6. Bounding the rounding. If you round up a couple of numbers, then you know that the answer must be a little less than the estimate. So $2.98 \times 17.75 =$ a number a little less than 60 or a little less than 54 depending on the amount of rounding.

7. Bounding with exponents is good. Example: If $10^{-3} = 0.001$ and $10^{-4} = 0.0001$ then $10^{-3.42}$ must be between 0.001 and 0.0001. Very often the only correct answer among multiple choice responses will be the one that satisfies these bounds so you don't need to be able to do the actual math.

8. Averaging out errors in rounding. Once you get good at rounding, and you are doing it a bunch in the same problem, keep track of when you are rounding up and when you are rounding down. If the number of rounding ups about equals the number of rounding downs, you would be amazed how close to accurate your final answer will be. Example, $(3.14)(0.88 \times 10^{-4}) / (2.1 \times 10^{-4})(4.7 \times 10^2) = 3 \times 10^{-3}$. Note that I rounded 3.14 down to 3, 0.88 up to 1, 2.4 down to 2 and 4.7 up to 5. The actual answer is 2.8×10^{-3} only I did it in about five seconds without a calculator. Standardized tests done without calculators EXPECT you to do your math this way. If you are having trouble finishing the physical science portion of an exam, math deficiencies are a likely culprit.

9. The multiple choice answers define how careful the estimates must be.

When you see answer choices like 4.7×10^{-2} versus 1.2×10^{-5} versus 9.5×10^2
you can estimate with extreme prejudice compared to

When you see answer choices like 4.7×10^{-2} versus 4.8×10^{-2} versus 4.6×10^{-2}
you don't get to round (this doesn't happen on calculator free exams unless someone doesn't like you.)

10. Let the science you know provide some boundaries—use this common sense when you attack a problem.

The weight of an atom is very, very small. A spontaneous reaction has a negative free energy. If the temperature goes up then the vapor pressure goes up. You can usually rule out HALF the answers in a multiple choice problem because you actually know the science.

STOP THE MYOPIA—GOOD TEST TAKERS DO NOT SIMPLY PLUG NUMBERS INTO THEIR CALCULATORS AND HIT SOLVE. THEY LOOK FOR ALL THE TRICKS OF THE TRADE (SEE ABOVE FOR MANY OF THEM) TO FIND A RIGHT ANSWER FASTER.

IF YOU DO NOT MAKE THE 10 RULES ABOVE A PART OF HOW YOU DO THE PHYSICAL SCIENCE PART OF A STANDARDIZED TEST, YOU MAKE YOUR LIFE UNNECESSARILY HARDER AND YOUR SCORE LESS THAN IT COULD BE.