ACTIVITY 1-B
Scientific Notation on the Calculator

The rules for working with numbers in scientific notation are not complicated:

- **MULTIPLICATION:** multiply the numbers and add the powers of ten
- **DIVISION:** divide the numbers and subtract the powers of ten
- **ADDITION/SUBTRACTION:** powers of ten must be the same; add/subtract the numbers; power of ten remains the same
- **STANDARD FORM:** the number part must be between 1 and 10.

The handheld scientific calculator does all of these steps automatically. The following example calculations were done using a Texas Instruments TI-30X SOLAR calculator. Steps on other calculators are similar although some key names and procedures are different. Consult the manual if you are using a different calculator.

(NOTE: When it says to "PRESS," that refers to a calculator key. If a number is being entered, simply press the digits in order.)

The following are the "Example Problems" from Activity 1.

Multiply 300 x 300,000,000

PRESS	CALCULATOR DISPLAY
[2nd] [5]	$0.^{00}$ (Scientific Notation Mode)
300 [X]	$3.^{02}$
300000000 [=]	$9.^{10}$

Divide: 4000000 / 3×10^8

PRESS	CALCULATOR DISPLAY
[2nd] [5]	$0.^{00}$ (Scientific Notation Mode)
400000000 [÷]	$4.^{08}$
3 [EE] 8 [=]	1.333333333^{00}

Subtract: 2.28×10^{11} - 1.50×10^{11}

PRESS	CALCULATOR DISPLAY
[2nd] [5]	$0.^{00}$ (Scientific Notation Mode)
2.28 [EE] 11 [—]	2.28^{11}
1.50 [EE] 11 [=]	7.8^{10}

<u>Additional Examples:</u>

Subtraction when the numbers have different powers of ten.

Subtract: 4.6×10^{10} - 3.9×10^{9}

PRESS	CALCULATOR DISPLAY
[2nd] [5]	$0.^{00}$ (Scientific Notation Mode)
4.6 [EE] 10 [—]	4.6^{10}
3.9 [EE] 9 [=]	4.21^{10}

Notice that all answers are given in standard form automatically. Also, in the last example there is no need to change the numbers to the same power of ten–that is done by the calculator.

ACTIVITY 2
Wavelength and Frequency

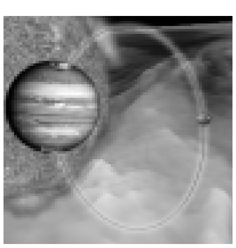
The frequency of a wave is defined as the number of waves created per second. As the waves propagate away from the source, the frequency also represents the number of waves that will pass a point per second. The unit of frequency is the hertz (Hz).

The wavelength, or length of a wave, is defined as the distance from one point on a wave to the corresponding point on the next wave. Since wavelength is a distance, the unit of wavelength is the meter (m).

Frequency, wavelength and speed are related by the equation:

$$c = \lambda f$$

where c is the speed of light (3×10^8 m/s),
λ (lambda) is the wavelength in meters (m),
and f is the frequency in hertz (Hz).



From this equation we can see that a long wavelength will have a low frequency while a short wavelength will have a high frequency since the product of these two quantities is constant.

Example problem: Find the wavelength of a radio wave with a frequency of 900 kHz.

$f = 900 \text{ kHz} = 900 \times 10^3 \text{ Hz} = 9 \times 10^5 \text{ Hz}$
$c = 3 \times 10^8 \text{ m/s}$
$\lambda = ?$

$c = \lambda f$ (Solve for λ)

$\frac{\lambda}{f} c = \lambda f \frac{1}{f}$

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

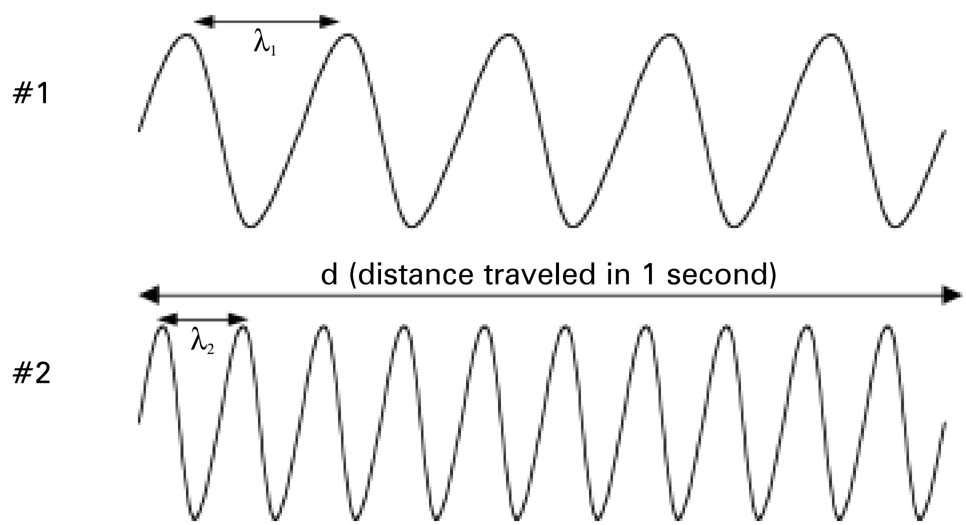
$\lambda = \frac{3 \times 10^8}{9 \times 10^5}$

$\lambda = .33 \times 10^3 = 3.3 \times 10^2 \text{ m}$ (330 m)

Problems

1. Find the wavelength of a radio wave with a frequency of 650 kHz.
2. Find the wavelength of a radio wave with a frequency of 1300 kHz.
3. Find the wavelength of a radio wave with a frequency of 90 MHz.
4. Find the wavelength of a radio wave with a frequency of 101.5 MHz.
5. AM radio stations have frequencies from 540-1700 kHz.
   a) Find the shortest wavelength AM radio signal.
   b) Find the longest wavelength AM radio signal.
6. FM radio stations have frequencies from 88-108 MHz.
   a) Find the longest wavelength FM radio signal.
   b) Find the shortest wavelength FM radio signal.

In this diagram, the distance (d) indicated represents the distance the waves travel in 1 second.



Wave #1 has 5 complete waves passing by in one second, while Wave #2 has 10 waves passing by in the same time. If you were to watch Wave #1 pass a point, the frequency would be 5 waves per second – 5 Hz. Wave #2 would have a frequency of 10 Hz. Wave #1 has half the frequency of Wave #2 and two times the wavelength. For both waves, the product of the wavelength and frequency are the same.

Answer key for Activity 2

1. 4.6×10^2 m (460 m)
2. 2.3×10^2 m (230 m)
3. 3.3 m
4. 2.96 m

5a. 1.76×10^2 m (176 m)

5b. 5.56×10^2 m (556 m)

6a. 3.4 m

6b. 2.8 m

ACTIVITY 3
Jupiter...

- The distance from the Sun to Jupiter is 778,330,000 km.
- The distance from the Sun to Earth is 149,600,000 km.
- In the following problem, assume that the planets are on the same side of the Sun (as close to one another as possible).

1. How long does it take for radio signals to travel from Jupiter to Earth?

   The frequency range of Jupiter radio emissions that can be detected on Earth is 8 MHz to 40 MHz.

2. Find the shortest wavelength Jupiter radio wave that can be detected on Earth.
3. Find the longest wavelength Jupiter radio wave that can be detected on Earth.
4. Find the wavelength of the Jupiter radio wave that has a frequency of 20.1 MHz.

Answer key for Activity 3

1. 2.1×10^3 s (34.9 minutes)
2. 7.5 m
3. 37.5 m
4. 14.9 m