

METRIC NOTATION

AET 1

Scientific Notation and its Application to Electrical Prefix Values

Courtesy of the United States Air Force

INTRODUCTION

Working with extremely large or small number can be a difficult chore. In the electronics field, such an extreme range of numbers is normally used.

INTRODUCTION

Mathematics is often the only way of analyzing a circuit; therefore it is necessary to have an understanding of some basic math principles.

INTRODUCTION

Given problems, calculate powers of ten IAW with PC checklist.

Convert Decimal Numbers to Scientific Notation and Vice Versa

Perform Math Operations of Numbers Expressed as Scientific Notation

INTRODUCTION

Identify Principles of Electrical Prefixes.

Relationship of Decimal Numbers and Electrical Prefixes

Relationship of Electrical Prefix Values to Other Prefix Value

INTRODUCTION

We will begin with the purpose of Scientific Notation and some associated terms as we learn how to convert decimal numbers to scientific notation and vice versa.

PRESENTATION

Purpose of using Scientific Notation ?

Scientific notation makes it very easy to work with very large and very small numbers

Numerical Coefficient, Base Number, and Exponent

$$4 \times 10^3$$

Numerical Coefficient 4

Base 10

Exponent 3

Converting Decimal Numbers to Powers of Ten

Move the decimal point to the desired position while counting the number of position changes. The number of position changes is the magnitude of the exponent.

If the decimal point is moved left, the magnitude of the exponent increases in a positive direction.

If the decimal point is moved right, the magnitude of the exponent increases in a negative direction.

**Powers of Ten and Equivalent Decimal Numbers
Using
Numerical Coefficient Number 1**

Decimal Point Place	Power Of Ten	Numerical Coefficient Equivalent	Decimal Point Changes
6	10^6	1,000,000	
5	10^5	100,000	
4	10^4	10,000	
3	10^3	1,000	
2	10^2	100	
1	10^1	10	
0	10^0	1	
-1	10^{-1}	0.1	
-2	10^{-2}	0.01	
-3	10^{-3}	0.001	
-4	10^{-4}	0.000,1	
-5	10^{-5}	0.000,01	
-6	10^{-6}	0.000,001	

+ exponent indicates “positive” direction
– exponent indicates “negative” direction

Converting Decimal Numbers to Powers of Ten

$$10,000 = 1.0000 \times 10^4$$

$$360 = 3.6 \times 10^2$$

$$7530 = 7.53 \times 10^3$$

$$.00485 = 4.85 \times 10^{-3}$$

Converting Decimal Numbers to Powers of Ten

Let's work several problems converting decimal numbers to powers of ten! Give me some examples.

Powers of Ten Expressed as Different Powers of Ten

$$**6,235 \times 10^2 = 62.35 \times 10^4 \text{ or } 62.35 (10^4)**$$

$$**8.36 \times 10^6 = 83,600 \times 10^2**$$

Powers of Ten Expressed in Scientific Notation

Example: 63.35×10^2 expressed in scientific notation would be 6.335×10^3 or $6.335 (10^3)$.

$$124 (10^4) = 1.24 (10^6)$$

Let's work several Problems!

Perform Math Operations of Numbers Expressed in Scientific Notation

Addition: (only like exponents can be combined)

1. Simplify numbers to common exponent
2. Add numerical coefficients
3. Use common exponent

$$\begin{aligned} &(4 \times 10^3) + (20 \times 10^2) \\ &4 \times 10^3 + 2 \times 10^3 \\ &4 + 2 \times 10^3 \\ &6 \times 10^3 \end{aligned}$$

Perform Math Operations of Numbers Expressed in Scientific Notation

Addition: (only like exponents can be combined)

Let's work several Problems!

Perform Math Operations of Numbers Expressed in Scientific Notation

Subtraction: (must use common exponent)

- 1. Simplify numbers to common exponent**
- 2. Subtract numerical coefficients**
- 3. Use common exponent**

$$\begin{aligned} &(80 \times 10^1) - (5 \times 10^2) \\ &8 \times 10^2 - 5 \times 10^2 \\ &8 - 5 \times 10^2 \\ &3 \times 10^2 \end{aligned}$$

Perform Math Operations of Numbers Expressed in Scientific Notation

Subtraction: (must use common exponent)

Let's work several Problems!

Perform Math Operations of Numbers Expressed in Scientific Notation

Multiplication:

1. Multiply the numerical coefficients
2. Algebraically add the exponent

$$\begin{aligned} & 2000 \times .00006 \\ & (2 \times 10^3) (6 \times 10^{-5}) \\ & 12 \times 10^{-2} \\ & 1.2 \times 10^{-1} \end{aligned}$$

Perform Math Operations of Numbers Expressed in Scientific Notation

Multiplication:

Let's work several Problems!

Perform Math Operations of Numbers Expressed in Scientific Notation

Division:

1. Divide the numerical coefficients
2. Subtract the exponent of the denominator from the exponent of the numerator

$$\begin{aligned} &.00008 \div 4,000,000 \\ &(8 \times 10^{-5}) \div (4 \times 10^6) \\ &2 \times 10^{-5-6} \\ &2 \times 10^{-11} \end{aligned}$$

Perform Math Operations of Numbers Expressed in Scientific Notation

Division:

Let's work several Problems!

Perform Math Operations of Numbers Expressed in Scientific Notation

Square Roots:

1. Simplify to “even” power of ten
2. Determine square root of number
3. Cut the even exponent in half

$$\sqrt{.000004}$$

$$\sqrt{4 \times 10^{-6}}$$

$$2 \times 10^{-3}$$

Perform Math Operations of Numbers Expressed in Scientific Notation

Square Roots:

Let's work several Problems!

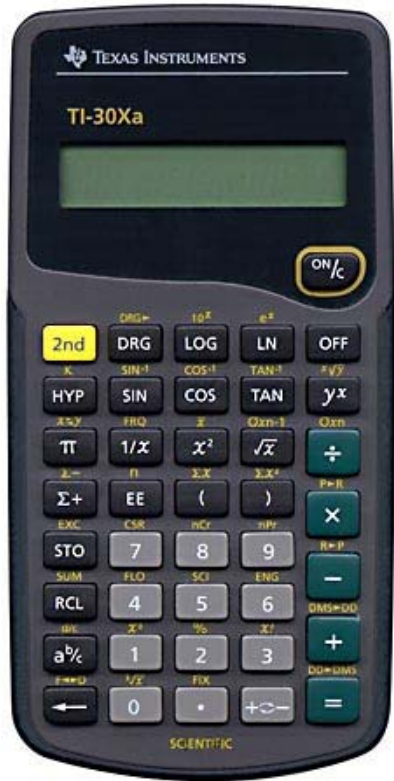
Engineering Notation

Move the decimal point to any convenient position in the numerical coefficient as long as the resulting exponent is either zero or a multiple of three (i.e. 9, 6, 3, 0, -3, -6, -9, -12). [This expression is what you get when using a calculator in the engineering mode, (TI-30 enter 2nd 6)]

$$2.45 \times 10^2$$
$$.245 \times 10^3 \text{ or } .000245 \times 10^6$$

Let's work several Problems!

Calculator Usage



Scientific notation using the TI-30 Calculator

Example: $(1.25 \times 10^6) (2 \times 10^{-2}) = 2.5 \times 10^4$ or 2.5^{04}

2nd 5 1.25 EE 6 X 2 EE 2 +/- =

Engineering notation using the TI-30 Calculator

Example: $(1.25 \times 10^6) (2 \times 10^{-2}) = 25 \times 10^3$ or 25^{03}

2nd 6 1.25 EE 6 X 2 EE 2 +/- =

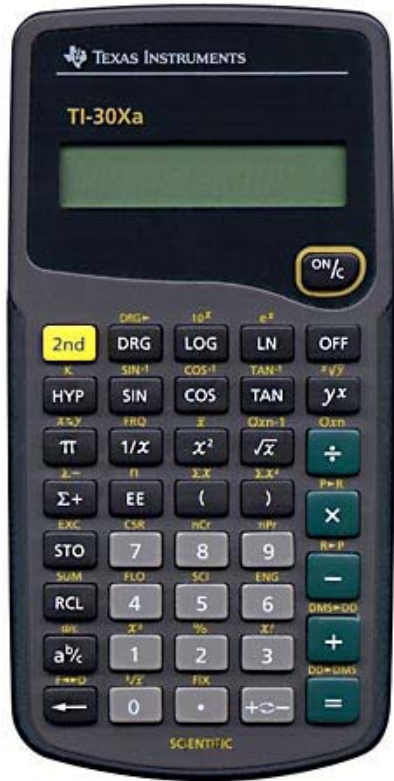
Scientific notation to engineering notation:

If a number is displayed in Engineering Notation, press ***2nd 5*** to display Scientific Notation.

If a number is displayed in Scientific Notation, press ***2nd 6*** to display Engineering Notation.

Calculator Usage

Let's work several Problems!



METRIC NOTATION

Appraisal

Objective 2a:

**Given Problems, Calculate
Powers of Ten IAW the PC
Checklist**

TRANSITION

**Laboratory Workbook and
Progress Check are next !**

ELECTRICAL PREFIXES

2b. Identify Principles of Electrical Prefixes. Meas: W

Relationship of Decimal Numbers and Electrical Prefixes

Relationship of Electrical Prefix Values to Other Prefix Value

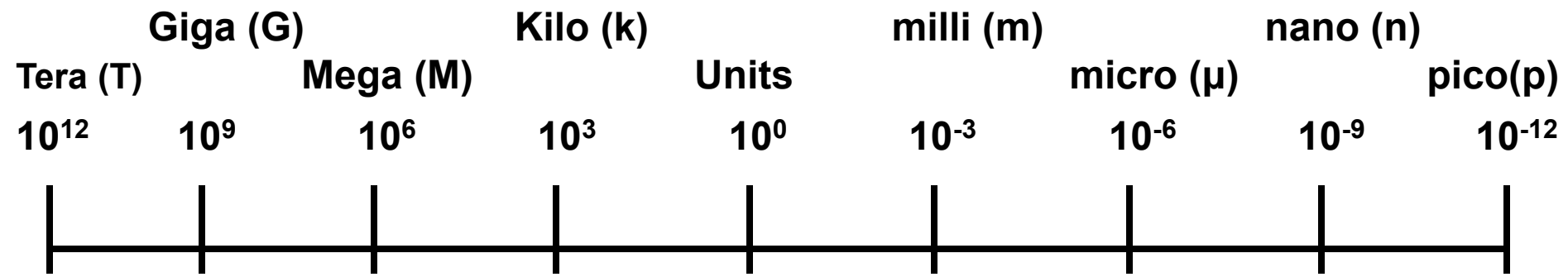
METRIC PREFIXES

What is the Relationship of decimal Numbers and Electrical Prefixes ?

Power of Ten, Decimal Equivalent, Metric Prefix Using Numerical Coefficient Number 1				
Decimal Point Place	Power Of Ten	Numerical Coefficient Equivalent	Metric Prefix Abbreviation	Decimal Point Changes
12	10^{12}	1,000,000,000,000	Tera T	
9	10^9	1,000,000,000	Giga G	
6	10^6	1,000,000	Mega M	
3	10^3	1,000	Kilo k	
0	10^0	1		
-3	10^{-3}	0.001	milli m	
-6	10^{-6}	0.000,001	micro μ	
-9	10^{-9}	0.000,000,001	nano n	
-12	10^{-12}	0.000,000,000,001	pico p	

Powers of Ten to Metric Prefixes

The next slide provides a number line and work area for metric prefix problems:



Example Problems

Converting Electrical Prefixes to other Prefixes

Procedure for converting from one Electrical Prefix to different Prefix:

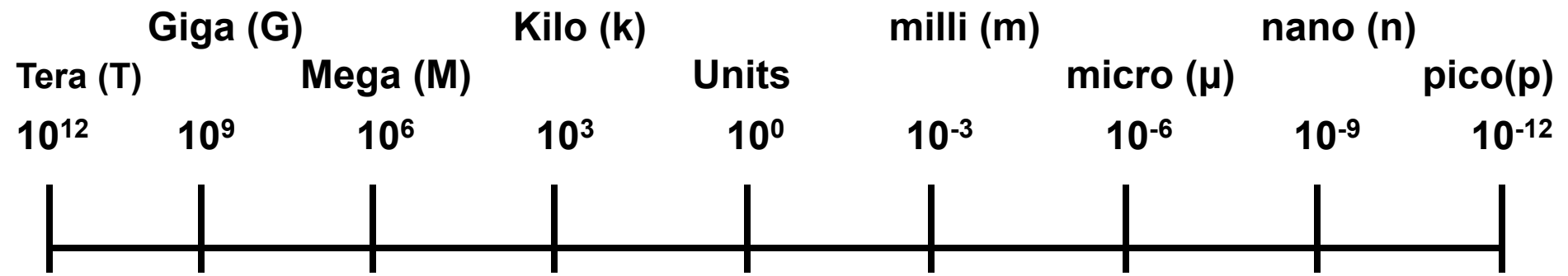
1. Replace the given prefix with the equivalent power of ten.
2. Relocate the decimal to the left or right while you adjust the power of ten.
3. When the power of ten matches the value of the desired prefix, replace it with the prefix.

Example:

$$350\text{k} = 350 \times 10^3 = .350 \times 10^6 = .350\text{M}$$

$$3\text{m} = 3 \times 10^{-3} = 3000 \times 10^{-6} = 3000\mu$$

The next slide provides a number line and work area for converting from one electrical prefix to another prefix:



Example Problems

METRIC NOTATION

Appraisal

Objective 2b:

**Identify Principles of
Electrical Prefixes**

CONCLUSION

Summary:

- (1) Scientific & Engineering Notation**
- (2) Addition & Subtraction**
- (3) Multiplication/Division & Square Root**
- (4) Metric Prefixes**

CONCLUSION

Remotivation:

Both Scientific Notation and Prefixes are essential math tools necessary to master the principles of electronics.

CONCLUSION

Assignment:

You should read the material and complete the HO 12 assignment on objective 2b.

Review the workbook assignments on objective 2a.

CONCLUSION

Closure:

**This concludes this lesson
on Metric Notation**

METRIC NOTATION

Express as a power of ten:

1. $0.0000000005 = \underline{\hspace{2cm}} (10^{-12})$

a. 5

c. 500

b. 50

d. 5000

METRIC NOTATION

Express as a power of ten:

2. $750 = \underline{\hspace{2cm}} (10^{+3})$

a. 750

c. 7.5

b. 75

d. .75

METRIC NOTATION

Express as a decimal:

3. $.680 \times (10^{+3}) =$ _____

a. 6.80

c. 680

b. 68.0

d. 6800

METRIC NOTATION

Express as a decimal:

4. $4700 \times (10^{-6}) =$ _____

a. .0047

c. .4700

b. .01470

d. 4.700

METRIC NOTATION

Express as scientific notation:

5. $470 \times (10^{+2}) =$ _____

a. $4.70 \times (10^{+4})$

c. $47.0 \times (10^{+4})$

b. $.470 \times (10^{+6})$

d. $4700 \times (10^{+1})$

METRIC NOTATION

Express as scientific notation:

6. $12.0 \times (10^{-2}) =$ _____

a. $1.20 \times (10^0)$

c. $12 \times (10^{+4})$

b. $1.20 \times (10^{-1})$

d. $.1200 \times (10^{+3})$

METRIC NOTATION

Express as scientific notation:

7. $4.3 \times (10^{-6}) + 2.05 \times (10^{-5})$

a. $2.48 \times (10^{-5})$ c. $24.8 \times (10^{-6})$

b. $24.3 \times (10^{-5})$ d. $2.48 \times (10^{-3})$

METRIC NOTATION

Express as scientific notation:

8. $90000 \times (10^0) - 700 \times (10^{+1})$

a. $8300 \times (10^{+1})$ c. $8.3 \times (10^{+5})$

b. $8.3 \times (10^{+4})$ d. $.83 \times (10^{+4})$

METRIC NOTATION

Express as scientific notation:

9. $3.5 \times 10^{+3} \div 70 \times 10^{+2}$

a. $.05 \times 10^0$

c. $50 \times 10^{+2}$

b. 5×10^{-1}

d. $500 \times 10^{+3}$

METRIC NOTATION

Express as another power of ten:

10. $4.29 \times 10^{+5} =$ _____

a. $429 \times 10^{+3}$

c. $4.29 \times 10^{+6}$

b. $42.9 \times 10^{+3}$

d. $.429 \times 10^{+5}$

METRIC NOTATION

Appraisal

Let's check your Answers.

METRIC NOTATION

Express as a power of ten:

1. $0.0000000005 = \underline{\hspace{2cm}} (10^{-12})$

a. 5

c. 500

b. 50

d. 5000

METRIC NOTATION

Express as a power of ten:

2. $750 = \underline{\hspace{2cm}} (10^{+3})$

a. 750

c. 7.5

b. 75

d. .75

METRIC NOTATION

Express as a decimal:

3. $.680 \times (10^{+3}) =$ _____

a. 6.80

c. 680

b. 68.0

d. 6800

METRIC NOTATION

Express as a decimal:

4. $4700 \times (10^{-6}) =$ _____

a. .0047

c. .4700

b. .01470

d. 4.700

METRIC NOTATION

Express as scientific notation:

5. $470 \times (10^{+2}) =$ _____

a. $4.70 \times (10^{+4})$

c. $47.0 \times (10^{+4})$

b. $.470 \times (10^{+6})$

d. $4700 \times (10^{+1})$

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Express as scientific notation:

6. $12.0 \times (10^{-2}) =$ _____

a. $1.20 \times (10^0)$

c. $12 \times (10^{+4})$

b. $1.20 \times (10^{-1})$

d. $.1200 \times (10^{+3})$

METRIC NOTATION

Express as scientific notation:

7. $4.3 \times (10^{-6}) + 2.05 \times (10^{-5})$

a. $2.48 \times (10^{-5})$ c. $24.8 \times (10^{-6})$

b. $24.3 \times (10^{-5})$ d. $2.48 \times (10^{-3})$

METRIC NOTATION

Express as scientific notation:

8. $90000 \times (10^0) - 700 \times (10^{+1})$

a. $8300 \times (10^{+1})$ c. $8.3 \times (10^{+5})$

b. $8.3 \times (10^{+4})$ d. $.83 \times (10^{+4})$

METRIC NOTATION

Express as scientific notation:

9. $3.5 \times 10^{+3} \div 70 \times 10^{+2}$

a. $.05 \times 10^0$

c. $50 \times 10^{+2}$

b. 5×10^{-1}

d. $500 \times 10^{+3}$

METRIC NOTATION

Express as another power of ten:

10. $4.29 \times 10^{+5} =$ _____

a. $429 \times 10^{+3}$

c. $4.29 \times 10^{+6}$

b. $42.9 \times 10^{+3}$

d. $.429 \times 10^{+5}$

TRANSITION

In this lesson we covered scientific / engineering notation, math operations, and calculator usage, now we can begin our next objective; Identify Principles of Electrical Prefixes

METRIC NOTATION

11. $(123 \times 10^3) =$ _____

a. 123k

c. 123M

b. 1.23k

d. 123G

METRIC NOTATION

12. $(74 \times 10^{-9}) =$ _____

a. 74p

c. 74T

b. 74n

d. 74M

METRIC NOTATION

13. $(374 \times 10^{-3}) =$ _____

a. 374p

c. 374T

b. 374m

d. 374M

METRIC NOTATION

14. $0.015n =$ _____

a. $15p$

c. $.15p$

b. $1.5p$

d. $.015p$

METRIC NOTATION

15. $0.015\text{m} =$ _____

a. 15μ

c. $.15\text{p}$

b. 1.5p

d. $.015\text{p}$

METRIC NOTATION

Appraisal

Let's check your Answers.

METRIC NOTATION

11. $(123 \times 10^3) =$ _____

a. 123K

c. 123M

b. 1.23K

d. 123G

METRIC NOTATION

12. $(74 \times 10^{-9}) =$ _____

a. 74p

c. 74T

b. 74n

d. 74M

METRIC NOTATION

13. $(374 \times 10^{-3}) =$ _____

a. 374p

c. 374T

b. 374m

d. 374M

METRIC NOTATION

14. $0.015n =$ _____

a. $15p$

c. $.15p$

b. $1.5p$

d. $.015p$

METRIC NOTATION

15. $0.015\text{m} =$ _____

a. 15μ

c. $.15\text{p}$

b. 1.5p

d. $.015\text{p}$