MATH ASSESSMENT

Course Prerequisites:

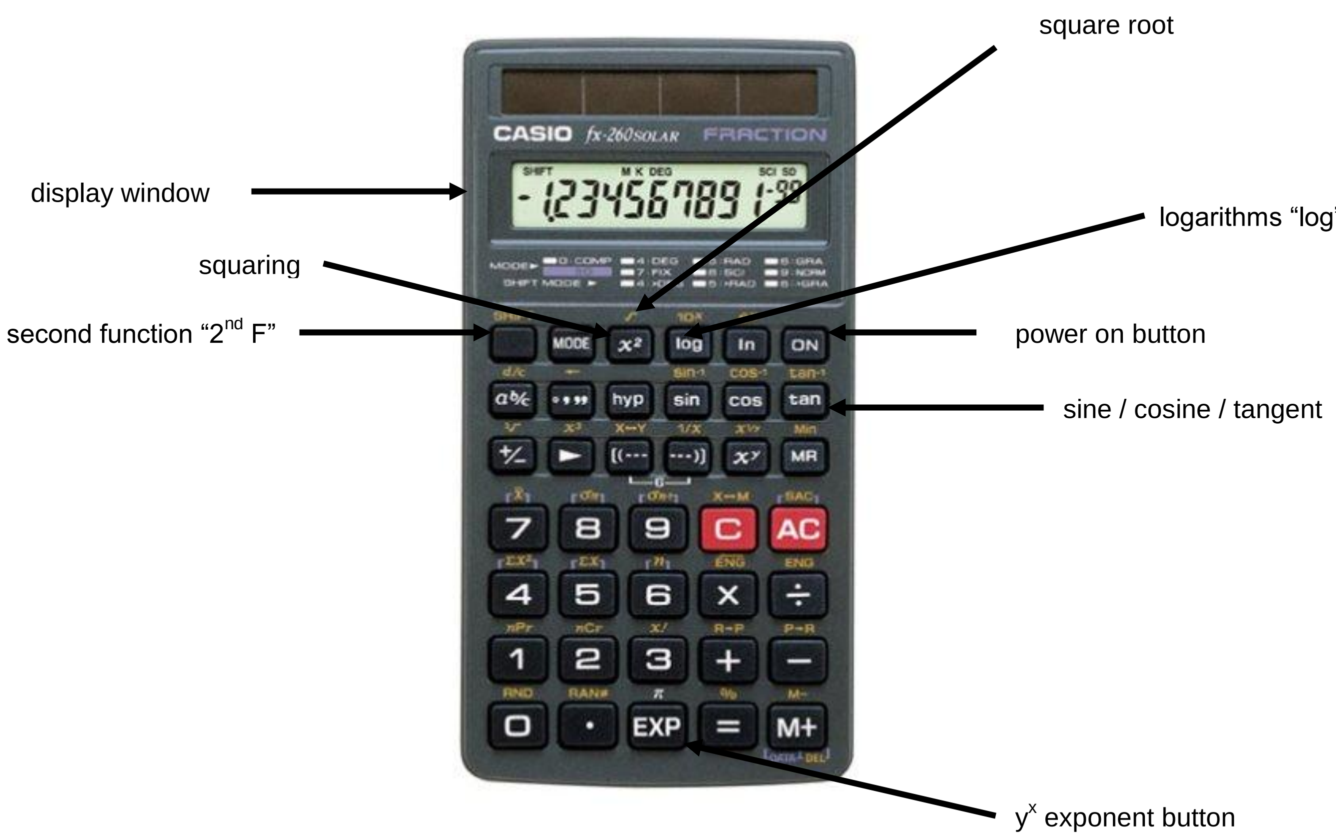
Math: Grade 11 or 12 technical math

English: Grade 11 reading skills

Calculator Operations:

Due to the multitude of formulas used in NDE, the inspector must use a calculator with the proper scientific functions to reliably use the various formulas. As calculators vary, time needs to be taken to familiarize yourself with the functions of your calculator.

The diagram shows the basic layout of most calculators.



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Symbols
Symbols are widely used to represent measured quantity. Most symbol designations are recognized internationally to allow for uniformity and standardization.

Symbols provide convenience of expressing a quantitative value (e.g. million is easily expressed by using an "M" derived from the Greek prefix "Mega").

μ	micro	c	centi
m	milli	G	Giga
M	mega	k	kilo
n	nano	T	Tera

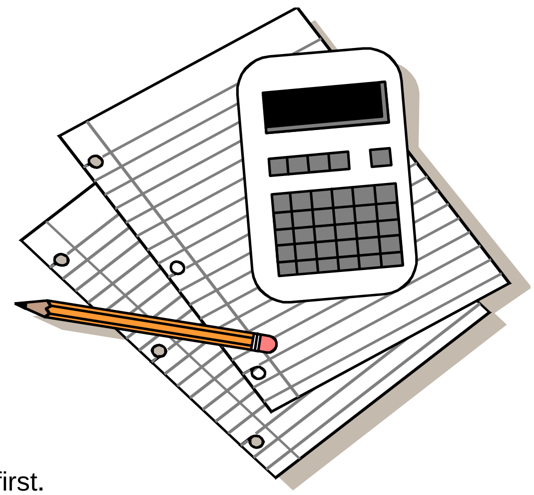
Here is a useful table of symbols commonly used in NDT.

Greek Name in English	Lower Case	Capital	Corresponding to English Letter
Alpha	α	Α	a (A)
Beta	β	Β	b (B)
Gamma	γ	Γ	g (G)
Delta	δ	Δ	d (D)
Zeta	ζ	Ζ	z (Z)
Eta	η	Η	h (H)
Theta	θ	Θ	q (Q)
Lambda	λ	Λ	l (L)
Mu	μ	Μ	m (M)
Pi	π	Π	p (P)
Rho	ρ	Ρ	r (R)
Sigma	σ	Σ	s (S)
Phi	φ	Φ	f (F)
Chi	χ	Χ	c (C)
Omega	ω	Ω	w (W)

Order of Operations

In mathematics, certain rules must be followed in solving equations. The rule is called BEDMAS:

B = brackets first
E = exponents
D = division
M = multiplication
A = addition
S = subtraction



e.g. 1 $(1 + 2) \times 3$

$= 3 \times 3$

$= 9$

e.g. 2 $(1 + 2) \times 3^2$

$= 3 \times 3^2$

$= 3 \times 9$

$= 27$

If there are no brackets, then all exponents are to be solved first.

e.g. 1 $2^2 \times 2^2$

$= 4 \times 4$

$= 16$

If there are no brackets or exponents, then all division is to be solved first.

e.g. 1 $1 + \frac{4}{2}$

$= 1 + 2$

$= 3$

If there are no brackets, exponents or division, then all multiplication is to be solved first and this rule is following BEDMAS.

e.g. 1 $50 \times 2 + 70 \times 2$

$=100 + 140$

$= 240$

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Exponents

Using a number or symbol, exponents express a power or a root of a power. Most calculators have a convenient function usually designated by "X^2". For simple squaring of numbers,

e.g. 1 5^2

$= 5 \times 5$

$= 25$

Of course the opposite of squaring is square root and again most calculators offer this simple function "√".

e.g. 1 $\sqrt{25}$

$= 5$

More complex exponents such as 5^3 can easily be solved by the y^x function on most calculators.

e.g. 1 5^3
$= 125$

e.g. 2 $3^3 \times 3^2$

$= 27 \times 9$

$= 243$

e.g. 3 $\frac{3^6}{3^2}$

$= \frac{729}{9}$

$= 81$

Solving for unknown exponents

Example: $1 = \frac{100}{10^x}$

Step #1: Move all unknowns to left-hand side $10^x = \frac{100}{1}$

Step #2: Following BEDMAS $10^x = 100$

Step #3: Remembering all unknowns moved to left-hand side move "3" to division position $x = \frac{100}{10}$

Step #4: Find the log of the numbers $x = \frac{100}{10} \rightarrow \frac{2}{1}$

Step #5: Following BEDMAS divide the log values for the answer $x = 2$

Algebra

Defined as a method of representing a family of problems by a single expression using symbols instead of actual numbers.

e.g. 1 If you are travelling in a car at 50 k/hr for 4 hours, the distance you will travel is 200 kms.

Algebraically, if
s = speed in k/hr
t = time in hr
d = distance in kms

then s x t = d

50 x 4 = 200

e.g. 2 If you travel for 2 hours at 50 k/hr and then 1.5 hours at 70 k/hr, how far have you travelled?

s x t = d
=(50 x 2) + (70 x 1.5)
=100 + 105
=205 kms

Taking a general equation with 4 symbols a, b, c and d which can stand for anything, it is important to realize that this can be written in a number of ways.

e.g. 3 $\frac{a}{b} = \frac{c}{d}$

Cross multiply $\frac{a}{b} \times \frac{c}{d}$

= a x d = c x b

Dividing both sides by d.

$= a = \frac{c \times b}{d}$

e.g. 1 If you travel for 2 hours at 50 k/hr and cover a distance of 100 km, what distance will you cover if you travel for 1.5 hours at 50 k/hr.

a = 2 hr original time
b = 1.5hr new time
c = 100 km original distance
d = x unknown distance

$$\frac{a}{b} = \frac{c}{d}$$

$$= \frac{2}{1.5} = \frac{100}{x}$$

$$= 2 * x = 1.5 * 100$$

Divide both sides by 2.

$$x = \frac{1.5 \times 100}{2}$$

$$x = \frac{150}{2}$$

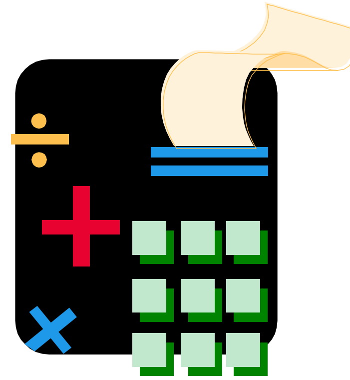
$$x = 75 \text{ km}$$

Simple check: 1.5 hours x 50 k/hr = 75km

Equations

In algebra, it is a statement that two expressions are equal. If the same process is performed on both sides of the equation (addition, subtraction, etc.), the method of solving is simple.

e.g. 1 $4x = 5 + 1x$



Any term moved from one side to the other changes its sign.

$$= 4x - 1x = 5$$

$$\therefore 3x = 5$$

$$x = \frac{5}{3}$$

$$x = 1.6$$

e.g. 2 When two sets of brackets are multiplied, each term in each set must be multiplied by each term in the other.

$$(x + y) * (x - y) = x * x \quad - \quad x * y \quad + \quad y * x \quad - \quad y * y$$

$$= x^2 - y^2$$

e.g. 3 A man is 3 times as old as his son, but 10 years ago, he was only 5 times his age. Find their ages.

Let the son's age be x.

Then the man's age in years is now 3x, and 10 years ago the man was (3x - 10) years old and the son (x - 10).

$$(3x - 10) = 5(x - 10)$$

$$= 3x - 10 = 5x - 50$$

Transpose x

$$= 3x - 5x = -50 + 10$$

$$= -2x = -40$$

$= 2x = 40$ Note: as both sides are negative, both can be made positive

$$x = \frac{40}{2}$$

$$x = 20$$

Son's age is 20 years old.

Father's age is 20 x 3 = 60 years old.

The rules are simple:

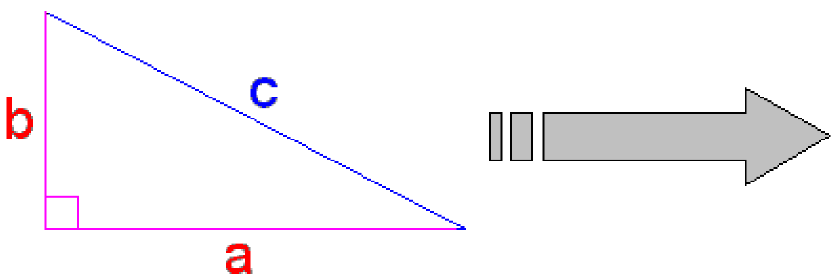
1.	Clear any fraction by multiplying all terms on both sides by an appropriate number.
2.	Remove brackets.
3.	Transpose all the terms in x to one side of the equation.
4.	Collect all terms on each side.
5.	Divide both sides by whatever number is in front of x.

Trigonometry

Trigonometry, in ancient times, was often used in the measurement of heights and distances of objects which could not be otherwise measured. For example, trigonometry was used to find the distance of stars from the Earth. Even today, in spite of more accurate methods being available, trigonometry is often used for making quick and simple calculations regarding heights and distances of far-off objects. For this, the value of various trigonometric functions is needed. A simple example is given below to demonstrate how trigonometry can help find the height or distance of an object.

The rule of Pythagoras applies to right angled triangles. It can be used to find an unknown side of a right angled triangle, or to prove that a given triangle is right angled.

The rule of Pythagoras states that in any right angled triangle with legs ‘a’ and ‘b’ and hypotenuse ‘c’...

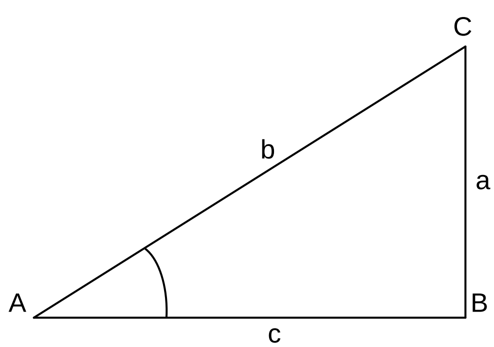


$$c^2 = a^2 + b^2$$

SIN, COS AND TAN FUNCTIONS

The trigonometric functions of angles are the ratios of the various sides of a triangle. Consider a right-angled triangle ABC as shown in the figure below.

The following terminology is useful.



- **Hypotenuse:** The side opposite to the right angle in a triangle is called the hypotenuse. Here the side AC is the hypotenuse.
- **Opposite Side:** The side opposite to the angle in consideration is called the opposite side. So, if we are considering angle A, then the opposite side is CB.
- **Base:** The third side of the triangle, which is one of the arms of the angle under consideration, is called the base. If A is the angle under consideration, then the side AB is the base.

For angle A (sometimes referred to as angle CAB), the following fundamental trigonometric functions can be defined.

Sine of A = sin A = Opposite Side / Hypotenuse = CB/CA = a/b

Cosine of A = cos A = Base / Hypotenuse = AB/CA = c/b

Tangent of A = tan A = Opposite Side / Base = CB/AB = a/c

Example

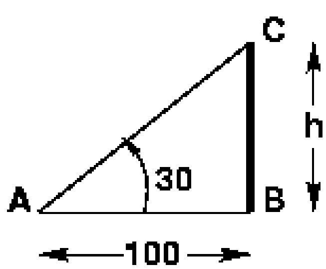
If the distance of a person from a tower is 100 m and the angle subtended by the top of the tower with the ground is 30^o, what is the height of the tower in meters?

Solution:

1. Draw a simple diagram to represent the problem. Label it carefully and clearly mark out the quantities that are given and those which have to be calculated. Denote the unknown dimension by say h if you are calculating height or by x if you are calculating distance.

2. Identify which trigonometric function represents a ratio of the side about which information is given and the side whose dimensions we have to find out. Set up a trigonometric equation.

3. Substitute the value of the trigonometric function and **solve** the equation for the unknown variable.



AB = distance of the man from the tower = 100 m

BC = height of the tower = h (to be calculated)

The trigonometric function that uses AB and BC is tan A, where A = 30^o.

So tan 30^o = BC / AB = h / 100

Therefore height of the tower $h = 100 \tan 30^o = (100) \frac{1}{\sqrt{3}} = 57.74$ m