TITLE:- ALGEBRA
LECTURER:- PETER RASMUS JEFF REDJEPI
DATE:- 15/4/81
EQUIPMENT:- Nil

Definition - Algebra is the science which investigates the methods of dealing with quantities expressed in symbols.

Any collection of symbols is an ALGEBRAICAL EXPRESSION.
The parts of an algebraical expression separated by the sigs '+' or '-' are called TERMS.

i.e. $3a + 2b - 4$ is an algebraical expression consisting of 3 terms.
The multiplication sign 'x' is usually omitted in algebra, thus
$2 \times a \times b = 2ab$.
A FACTOR can be either the number or the letter of the algebraical expression.
One factor is usually expressed as a COEFFICIENT of the other, and it is generally the numerical factor which is the coefficient, thus '2' is the coefficient of 2ab.

When the arithmetical values of the symbols forming an expression are known, the arithmetical value of the expression may be found by SUBSTITUTING these values.

e.g. $a = 2$, $b = 3$, $c = 0$

Then $5ab - 2b^2 + abc = 5\text{x}2\text{x}3 - 2\text{x}3\text{x}3 + 2\text{x}3\text{x}0$
$= 30 - 18 + 0$
$= 12$

Algebraical Addition

If the quantities to be added together have the same sign, add them as in arithmetic and prefix the common sign to the result:-
$a + a + a = 3a$, $-a -a -a = -3a$.
If the quantities have different signs, subtract the lesser from the greater, and to the result prefix the sign of the greater:-
$-a -a + 3a = a$, $b + 2b - 6b = -3b$.

The '-' sign is used to indicate "direction" in a general sense. For example, if +10 refers to the height of 10m above a certain level, then -10 would refer to a depth of 10m below that same level.

Only LIKE terms may be added together, e.g. the following terms could not be added $a + b + a^2 + b^2 + 2ab$.
When it is required to find the sum of two or more like terms, the positive terms and the negative terms are added together separately, and the algebraical sum of the results is found.

e.g. add; $a^3 - 3a^2 + 3a - 1$, $2a^3 + 5a - 2$
$3a^2 - 9a^3 - 2a - 7$, and $2a - 3a^3$

a^3	-	$3a^2$	+	$3a$	-	1
$2a^3$			+	$5a$	-	2
$-9a^3$	+	$3a^2$	-	$2a$	-	7
$-3a^3$			+	$2a$		
$-9a^3$			+	$8a$	-	10

Algebraical Subtraction
If 4a is subtracted from 6a, the result is plainly 2a, but it appears more difficult to subtract -4a from 6a. By using a bracket to write down the problem it can be resolved more easily, i.e.
$6a - (-4a)$

By following the rules:- (a) If the two signs are the same, then both may be replaced by a '+' sign (b) If the signs are not the same, then both may be replaced by a '-' sign

e.g. $6a - (-4a) = 6a + 4a = 10a$
$6a - (+4a) = 6a - 4a = 2a$

Algebraical Multiplication

It has already been explained that a x b x c is usually written as abc.
Therefore 3a x 4b can be simplified

i.e. $3 \times a \times 4 \times b = 12ab.$

$a \times a = a^2$, $a \times a \times a = a^3$

$\therefore\ a^2 \times a^3 = a \times a \times a \times a \times a = a^5$

The indices are ADDED when multiplying two or more terms.

When multiplying terms having negative quantities, observe the following rules.
If the signs are similar, then the answer will be "+", but if the signs are disimilar, then the answer will be "-".

e.g. $a \times b = ab$
$-a \times b = -ab$
$a \times -b = -ab$
$-a \times -b = ab$

When expressions containing two or more terms must be multiplied, then every term in one expression must be multiplied by every term in the other expression(s).

e.g. multiply a-b by c-d

$$\begin{array}{r} a - b \\ \underline{c - d} \\ ac - bc - ad + bd \end{array}$$

Algebraical Division

The rules of division may be deduced from those of multiplication

$a \times b = ab \quad \therefore \frac{ab}{a} = b$

$-a \times b = -ab \quad \therefore \frac{-ab}{-a} = b$

$a \times -b = -ab \quad \therefore \frac{-ab}{a} = -b$

$-a \times -b = ab \quad \therefore \frac{ab}{-a} = -b$

The indeces of a term are subtracted from other indeces of similar terms.

e.g. $a^5 \div a^3 = a^2$

When expressions containing two or more terms must be divided one into the other, then every term in one expression must be divided by every term in the other.

e.g. Divide $6a^2 + a - 15$ by $2a - 3$

$$\begin{array}{r} 2a - 3 \overline{)\ 6a^2 + a - 15 \ (3a + 5} \\ \underline{6a^2 - 9a} \\ 10a - 15 \\ \underline{10a - 15} \\ \end{array}$$

$$\frac{6a^2 + a - 15}{2a - 3} = 3a + 5$$

Brackets

Expressions contained within a bracket are intended to be treated as a whole. When the brackets are removed, every term within the bracket must be multiplied by the term or the sign immediately before the bracket.

e.g. $2a(a + b - c) = 2a^2 + 2ab - 2ac$
$6a - (a + b + c) = 6a - a - b + c$
$= 5a - b + c$

When more than one pair of brackets are used, i.e. one set within another, then the inner set should be removed first.

e.g. $2(2a + 3b(b-c))$
$= 2(2a + 3b^2 - 3bc)$
$= 4a + 6b^2 - 6bc.$

Expressions containing Fractions

The same rules apply in algebra as in arithmetical problems

e.g. $\frac{a-1}{2} - \frac{a-2}{3}$

the L.C.M. is 6

$\therefore \frac{3(a-1) - 2(a-2)}{6}$

$= \frac{3a - 3 - 2a + 4}{6} = \frac{a+1}{6}$

e.g. $\frac{a}{bc} + \frac{a}{cd} + \frac{a}{db} = \frac{ad + ab + ac}{bcd} = \frac{a(d + b + c)}{bcd}$

TITLE:- FRACTIONS

LECTURER:-

DATE:-

EQUIPMENT:- Nil

A fraction consists of two parts:-

1. Denominator - the part below the line - indicates how many equal parts a UNIT has been divided into.
2. Numerator - The part above the line - indicates how many of these parts have been take.

A UNIT is any whole number.

A PROPER fraction has a numerator which is always smaller that the denominator e.g. $\frac{3}{4}$ $\frac{7}{8}$

An IMPROPER fraction has a numerator which is larger than the denominator e.g. $\frac{4}{3}$ $\frac{8}{7}$ $\frac{15}{4}$

a MIXED NUMBER is the sum of an integer and a proper fraction

e.g. $6\frac{3}{4} = 6 + \frac{3}{4}$

A mixed number may be changed into an improper fraction by

1. Multiplying the Integer by the denominator, and then
2. Adding to it the numerator.

e.g $5\frac{3}{8} = \frac{43}{8}$

The reverse is also applicable, i.e. an improper fraction may be changed to a mixed number by dividing the numerator by the denominator.

e.g. $\frac{43}{8} = 5\frac{3}{8}$

Addition & Subtraction of Fractions

$\frac{1}{4}$ may be added to $\frac{3}{4}$ by adding together the numerators, and placing them over the common denominator.

i.e. $\frac{1}{4} + \frac{3}{4} = \frac{4}{4} = 1$

Similarly, $\frac{1}{4}$ may be subtracted from $\frac{3}{4}$ by subtracting the numerators.

i.e. $\frac{3}{4} - \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$

This cannot be done where the denominators are different

e.g. $\frac{5}{6} + \frac{3}{4}$

A common denominator must first be found. There may be more than one common denominator which may be found, but it is easier to calculate if the LOWEST COMMON DENOMINATOR is found. This is usually called the L.C.M. or LOWEST COMMON MULTIPLE.

The LCM of $\frac{5}{6}$ and $\frac{3}{4}$ would be 12.

This is found by multiplying $\frac{5}{6}$ by 2, and $\frac{3}{4}$ by 3

$\therefore \frac{5}{6} + \frac{3}{4}$ becomes $\frac{10}{12} + \frac{9}{12} = \frac{19}{12} = 1\frac{7}{12}$

Subtraction is carried out in the same way.

$\frac{5}{6} - \frac{3}{4}$ becomes $\frac{10}{12} - \frac{9}{12} = \frac{1}{12}$

This method is used, regardless of how many fractions are to be added or subtracted.

e.g. $\frac{3}{4} + \frac{5}{8} - \frac{1}{6} + \frac{1}{12} = \frac{18 + 15 - 4 + 2}{24} = \frac{31}{24}$

Multiplication

A fraction may be multiplied either by a whole number, or another fraction. To carry out multiplication, multiply all numerators together, and multiply all denominators together - the whole number is regarded as a numerator.

e.g. $3 \times \frac{5}{8} \times \frac{3}{4} = \frac{45}{32}$

The word "OF" means MULTIPLY e.g. What is $\frac{3}{4}$ of $\frac{7}{8}$

$$\frac{3}{4} \times \frac{7}{8} = \frac{21}{32}$$

CANCELLATION, before carrying out multiplication, will simplify the problem

e.g. $\frac{\cancel{33}^{3}}{\cancel{5}_{1}} \times \frac{\cancel{20}^{4}}{\cancel{11}_{1}}$ becomes $\frac{3}{1} \times \frac{4}{1} = 12$

Division

If one fraction is to be divided into another, INVERT the divisor and treat the problem as for multiplication

e.g. divide $\frac{7}{8}$ by $\frac{1}{4}$

$$\frac{7}{8} \div \frac{1}{4} = \frac{7}{8} \times \frac{4}{1} = \frac{28}{8} = 3\tfrac{1}{2}$$

Problems

It is often required to express one quantity as a fraction of another. The quantities may be mass, length, money, etc.

e.g. 1. Express 4 km as a fraction of 200 km.

i.e. 4 Km is $\frac{4}{200} = \frac{1}{50}$ of 200 Km

e.g. 2. The cost of an item is increased by 33%. If the original cost was $100, what is the fractional increase.

i.e. $\frac{33}{100} = \frac{1}{3}$ of the original cost

The basic rules are:-

1. Express both quantities in terms of the same unit.
2. Form a fraction having the first quantity as the numerator and the second quantity as the denominator.

Decimal Fractions

Express .381 as a fraction

$$.381 = \frac{3}{10} + \frac{8}{100} + \frac{1}{1000} = \frac{300 + 80 + 1}{1000} = \frac{381}{1000}$$

Reduce .333 to a fraction

$$.333 = \frac{3}{10} + \frac{3}{100} + \frac{3}{1000} = \frac{300 + 30 + 3}{1000} = \frac{1}{3}$$

Simplify $\frac{.75 + .125 - .1875}{.0375}$

$$= \frac{.6875}{.0375} = \frac{6875}{375} = 18.33$$

TITLE:- FORMULAE

LECTURER:- R. KOPPECHOBER I SMITH

DATE:- 1-5-81

EQUIPMENT:- Nil

Definition

A formula is a statement of a relation between two or more variable quantities from which the value of any one of the quantities can be found if we are given the quantities of the others.

e.g. If $T = 6$ Find E

$$E = \tfrac{3}{4}T + 9$$

$$E = \frac{3 \times 6}{4} + 9$$

$$= 4.5 + 9 = 13.5$$

i.e. we arrive at a numerical answer without any algebraical expressions or terms.

When a formula is more complex than the above example, it may be necessary to rearrange the terms or TRANSPOSE the formula to allow the calculation to be solved. e.g.

$$R = t(1 + pT)$$

If $R = 10$, $t = 20$, $p = 0.5$ find T

$$R = t + tpT$$

$$R - t = tpT$$

$$\frac{R - t}{tp} = T$$

$$T = \frac{10 - 20}{20 \times 0.5} = \frac{-10}{10} = -1$$

Follow the basic rules of algebra for multiplication, division, addition and subtraction, and also remember that:- A formula is balanced i.e. the terms on the left of the equals sign are equal to the terms on the right of the bracket.

Whatever is done to one side must also be done to the other.

e.g. $R = t + tpT$

The objective is to isolate T.

Step 1 subtract t from both sides of the formula

i.e. $R - t = \cancel{t} + tpT \cancel{- t} = tpT$

Step 2 divide both sides by t

i.e. $\frac{R - t}{t} = \frac{\cancel{t}pT}{\cancel{t}} = pT$

Step 3 divide both sides by p

$$\frac{R - t}{tp} = \frac{\cancel{p}T}{\cancel{p}} = T$$

When a formula consists of terms which must be divided one into another, then it is simpler to CROSS-MULTIPLY. This is a quick method of achieving the above steps.

e.g. $\frac{ab}{c+d} = \frac{ef}{g+h}$

is the same as $ab(g + h) = ef(c + d)$

$= abg + abh = efc + efd$

The balance of the formula is retained and solution becomes easier.

TITLE:- EQUATIONS

LECTURER:-

DATE:-

EQUIPMENT:- Nil

Definition

An equation is a statement that two expressions are equal.
An IDENTITY is an equation that is true for all values of the letters involved.

e.g. $3a + 2a = 5a$

i.e. the equation is true regardless of the value of 'a'. A CONDITIONAL EQUATION is one which is true for only one value of the letters involved.

e.g. $3a = 6$

Only when a = 2 is the equation true, and this value is known as the ROOT of the equation.
The process of finding the root is known as SOLVING the equation.

Simple Equations

Where an equation contains only one unknown quantity, it is called a simple equation.
When solving a simple equation, collect all terms containing the unknown quantity onto one side of the equals sign, and combine these terms into a simpler term.
The rules explained in previous lectures apply

e.g.
$$\begin{aligned} 3a - 2(a - 5) &= 5a + 4(a + 5) \\ 3a - 2a + 10 &= 5a + 4a + 20 \\ 3a - 2a - 4a - 5a &= 20 - 10 \\ -8a &= 10 \\ a &= \frac{5}{-4} \end{aligned}$$

Note that as the terms are moved across the equals sign, the sign prefixing the term changes.

i.e. +5a becomes -5a etc.

This applies ONLY where addition and/or subtraction is carried out. It does NOT apply to multiplication or division.

Symbolical Expression

To enable everyday problems to be solved by algebra, we must be able to express the problem in terms of algebraical symbols. Some examples are:-

If 'a' is any number, double that number is 2a, half that number is $\frac{a}{2}$ and b times that number is ab.

If a and b are two numbers, of which b is greater than a, then the sum of the numbers is a + b and the difference is b - a.
If 'a' is one part of b, the other part is b - a.
If 'a' is the product of b and c, bc = a or $c = \frac{a}{b}$

$\$a = 100a$ cents.
If an article is bought for $\$a$ and sold for \$6, the profit is $\$(b-a)$ and the percentage profit is

$$\frac{\text{gain}}{\text{buying price}} \times 100 = \frac{100(b - a)}{a}$$

In solving a problem, follow the general rules:-
Denote the unknown quantity by a symbol - say 'a'.
Write down an equation expressing the conditions of the problem.
Solve the equation to find the unknown quantity.

Simultaneous Equations

Where a problem contains two unknown quantities, it is impossible to solve by the above methods.

e.g. $a + b = 5$ There are many solutions, i.e.

$a = 5, b = 0$ $\quad a = 3, b = 2$ $\quad a = 1, b = 4$ etc.

If we are given a further equation containing the same unknown quantities, we are able to determine the value of both by SUBSTITUTION.

e.g. $a + b = 5$ ..... (1)

$2a + b = 7$ ..... (2)

From (1) $b = 5 - a$..... (3)

By substituting b in equation (3) into equation (2) we have

$2a + 5 - a = 7.$

i.e. we have eliminated 'b' and made a simple equation

$\therefore a = 7 - 5 = 2$

Now by substituting $a = 2$ into equation (1) we can find b

equation (1) $= 2 + b = 5$

$\therefore b = 5 - 2 = 3$

$\underline{a = 2} \quad \underline{b = 3}$

Another method is to multiply one of the equations by a number or a letter so that corresponding terms in each equation may be either added or subtracted to eliminate them.

e.g. $a + b = 5$ ..... (1)

$2a + b = 7$ ..... (2)

Multiply (2) by -1

$a + b = 5$ ..... (1)

$-2a - b = -7$ ..... (3)

Subtracting $-a \quad 0 = -2$

$\therefore \underline{a = 2}$

by substituting $a = 2$ in (1)

we have $2 + b = 5$

$b = 5 - 2 = 3$

$\underline{a = 2}, \quad \underline{b = 3}$

Quadratic Equations

An equation that contains the SQUARE (a^2) of the unknown quantity (a) is called a quadratic equation.

e.g. $4a^2 = 3$

$a^2 = \frac{3}{4}$

$a = \pm\sqrt{\frac{3}{4}}$

The square root may be either positive or negative because a positive quantity has two square roots.

i.e. the square root of 9 may be +3 or -3.

It is impossible to find the square root of a negative quantity.

An equation:- $a = \pm\sqrt{-9}$ is said to have IMAGINARY roots.

In addition to an equation having the square of an unknown quantity, it can also contain the first power of the quantity

e.g. $a^2 = a + 6$

The solution may be found by one of the following methods.

1. Solution by factors

$a^2 = a + 6$

or $a^2 - a - 6 = 0$

$\therefore (a - 3)(a + 2) = 0$

i.e. the equation is satisfied if:-

$a - 3 = 0$ ..... (1)

or $a + 2 = 0$ ..... (2)

(1) gives $a = 3$, (2) gives $a = -2$

i.e. the roots of the equation are 3 and -2.

If a = 3

From the original equation,

$$\begin{aligned} a^2 &= a + 6 \\ 3^2 &= 3 + 6 \\ 9 &= 9 \end{aligned}$$

$\therefore$ a = 3 satisfies the equation.

2. Solution by Completing the Square

Where more complex quadriatic equations occur, this is the method by which they may easily be solved.

$a^2 + 2ab + b^2$ is a COMPLETE SQUARE, i.e. it is the expanded form of $(a + b)^2$

The coefficient of a in the middle term is 2b.
Hence the last term may be formed by SQUARING HALF THE COEFFICIENT OF 'a'.

i.e. $\left(2b \times \frac{1}{2}\right)^2 = b^2$

e.g. Solve $a^2 = 10a + 11$

or $a^2 - 10a = 11$

Add $(\frac{1}{2}$ of $10)^2$ to both sides i.e. 25

$a^2 - 10a + 25 = 11 + 25$

$\therefore (a - 5)^2 = 36$

$a - 5 = \pm\sqrt{36}$

$a - 5 = \pm 6$

The equation is now reduced to two simple equations

(1) $a - 5 = +6$

or (2) $a - 5 = -6$

i.e. $a = 11$ or $a = -1$

The roots of the equation are 11 and -1.
The complete process is summarised.
Arrange the terms so that only the numerical term is on the R.H.S.
Make the coefficient of "a" unity.
Complete the square on the left hand side by adding:-
The square of half the coefficient of 'a' to each side
Extract the square root of each side.
Solve the resulting two simple equations.

TITLE:- TRIGONOMETRY

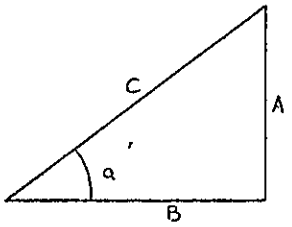
LECTURER:-

DATE:-

EQUIPMENT:- Nil

Trigonometry is the branch of maths that deals with the relationships held between the sides and angles of right angle triangles. In any right angle triangle, the ratios between the sides always remain the same.

i.e. for the triangle shown



Sine 'a' = $\frac{A}{C}$ = $\frac{\text{opposite}}{\text{hypotenuse}}$

Cosine 'a' = $\frac{B}{C}$ = $\frac{\text{adjacent}}{\text{hypotenuse}}$

Tangent 'a' = $\frac{A}{B}$ = $\frac{\text{opposite}}{\text{adjacent}}$

The inverse of these ratios are:-

Cosec 'a' = inverse of sin 'a' = $\frac{C}{A}$

Sec 'a' = inverse of cos 'a' = $\frac{C}{B}$

Cot 'a' = inverse of tan 'a' = $\frac{B}{A}$

In any right angle triangle, the hypotenuse will always be longer than the other two sides. For this reason, sin and cosine can NEVER be greater than 1.

Three values of angle 'a' which are the most commonly used and remembered angles are shown.

Angle of (a)	Sine	Cosine	Tan
30^o	0.5	0.866	0.5774
45^o	0.7071	0.7071	1
60^o	0.866	0.5	1.7321

Many trigonometrical problems also require the use of Pythagoras' theorem. ie. The square on the hypotenuse is equal to the sum of the squares on the other two sides.

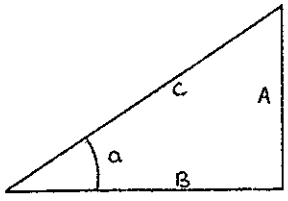
Relations between sin, cos, & tan of the same angle

By observing the sin and cos tables it will be seen that COMPLEMENTARY angles (two angles whose sum is 90^o) have the same value.

i.e. Cos a = Sin (90 - a)
Cos (90 - a) = Sin a

e.g. Cos 55^o = 0.5736
Sin (90 - 55) = 35^o = 0.5736

Similarly
Sin 55^o = 0.8192
Cos 35^o = 0.8192



$\frac{\text{Sin a}}{\text{Cos a}} = \tan a$

$\frac{\text{Sin a}}{\text{Cos a}} = \frac{A}{C} \div \frac{B}{C} = \frac{A}{\not{C}} \times \frac{\not{C}}{B} = \frac{A}{B} = \tan a$

$\underline{\sin^2 a + \cos^2 a = 1}$

$$\sin^2 a + \cos^2 a = \frac{A^2}{C^2} + \frac{B^2}{C^2} = \frac{A^2 + B^2}{C^2}$$

By Pythagoras, $A^2 + B^2 = C^2$

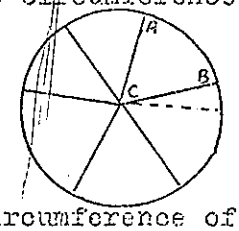
i.e. $$\frac{A^2 + B^2}{C^2} = \frac{C^2}{C^2} = 1$$

Trigonometrical Ratios

Most text books contain a table of these ratios where it is possible to obtain the values of Radians, Chords, Sine, Tangent, Cotangent, and cosine and compare their relative values quickly on the one page. All but the first two (Radians and Chords) have been explained.

Radian

A radian is the angle subtended at the centre of a circle by an arc of the circumference equal in length to the radius.



i.e. length of arc A - B is equal to radius A - C.

The angle ACB is the same for ALL circles- It is called a RADIAN.

The circumference of a circle is 3.1415 times longer than its diameter. This is a constant for all circles and is denoted by π (pi).

Length of circumference is therefore $2\pi r$ (r = radius)
If length A - B = r,
Then the number of radians in a circle = $\frac{2\pi r}{r} = 2\pi$ radians

One radian, therefore, has $\frac{360}{2} = \frac{360}{6.283} = \underline{57.3^\circ}$

Angle ACB = 57.3° = 1 radian.

Chords

Because length of arc A - B is proportional to the angle it subtends, then the straight line from A to B is also proportional to the same angle.
This applies regardless of the magnitude of the angle. The relationship between the length of the chord and the angle may be found from the table of TRIGONOMETRICAL RATIOS.

e.g. A chord is 7.65 cm long, the radius is 10 cm long. From the table, the angle is 45°.

TITLE:- LOGARITHMS

LECTURER:-

DATE:-

EQUIPMENT:- Log tables

Logarithms are a means of simplifying cumbersome multiplication and division problems into addition and subtraction problems. A set of logarithm tables are required.
The numbers to be multiplied together must first be expressed in a different form i.e. the CHARACTERISTIC and the MANTISSA must be determined.
The characteristic is the part which tells us how many figures appear in the number to the LEFT of the decimal point.

e.g. The characteristic of 1.25 is 0
" " " 12.5 is 1
" " " 125 is 2
" " " 0.125 is -1 or $\bar{1}$ (bar 1)

It will be seen that the characteristic is always one (1) less than the actual number of figures to the left of the decimal.
The mantissa is the number found by referring to the log tables. When locating the mantissa, the decimal point is ignored, i.e. The mantissa of the above examples will be exactly the same:- .0969.
The characteristic and mantissa must be written down together to give the log.

log 1.25 = 0.0969
log 12.5 = 1.0969
log 125 = 2.0969
log 0.125 = 2.3876

If the examples given were to be multiplied together, then all that is necessary is to ADD the logs. The answer would be 2.3876.
It is now necessary to reverse the answer from a log to a number, i.e. find the ANTILOG.
To do this, ignore the characteristic (2) and locate .3876 in the antilog table.

Antilog of .3876 = 2441

This number has a characteristic of 2, therefore the decimal is placed thus 244.1

1.25 x 12.5 x 125 x 0.125 = 244.1

Division of numbers is carried out in the same manner as for addition with the exception that the logs are SUBTRACTED.
Where complex calculations are involved, the use of logs should be in 3 stages.

1. Find the logs of all numerators and add them.
2. Find the logs of all denominators and add them.
3. Subtract the answers.

e.g. $\dfrac{3.241 \times 6.66 \times 4.7}{2.8 \times 3.33}$

log 3.241	= 0.5106	log 2.8 =	0.4472
log 6.66	= 0.8235	log 3.33 =	0.5224
log 4.7	= 0.6721	TOTAL	0.9696
TOTAL	2.0062		

Subtract 0.9696 from 2.0062 = 1.0266
Antilog of 1.0266 is 10.63

Powers and Roots

$6^5 = 6 \times 6 \times 6 \times 6 \times 6 = 7776$

Calculating can be cumbersome, but may be done simply by using logs.
Find the log of the number = log 6 = 0.7782
And multiply it by the power 5
3.8910

Antilog of 3.8910 is 7780

Similarly, the root of a number may be found by logs. Find the log of the number and divide it by the root e.g. Find $\sqrt[4]{20736}$

log 20736 = $\dfrac{4.3167}{4}$ = 1.0791

Antilog of 1.0791 = 1.99 (12)

TITLE:- VECTORS

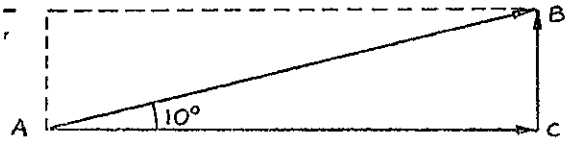
LECTURER:-

DATE:-

EQUIPMENT:- Nil

A VECTOR is a line drawn on paper to indicate that a quantity is moving in a certain direction RELATIVE to some fixed point.
A VECTOR QUANTITY may represent force, velocity, momentum etc. of a quantity.
e.g. a car travelling along a straight, horizontal road at a constant speed would have a vector thus:-

A car travelling on a straight road, but at an incline of 10° would have a vector:-



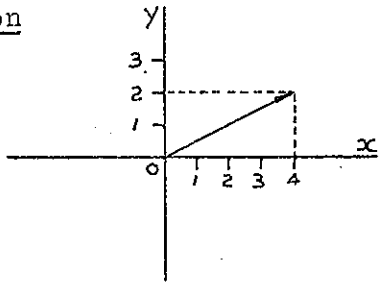
Where the car is travelling in two directions at once, i.e. horizontally (A - C) and vertically (C - B).
The vector A - B is the sum of AC and CB. Because AC & CB are in different directions, they cannot be added arithmetically, but may calculated in a number of ways.

1. Parallelogram Law
   If the vectors are drawn exactly to scale, then AB may be measured.
   A more accurate method is to use Pythagoras' theorem.
   i.e.

$$AB^2 = AC^2 + BC^2$$
$$AB = \sqrt{AC^2 + BC^2}$$

This method is suitable where only a few vectors are involved. Where larger numbers of vectors must be calculated, a simpler method may be employed, i.e. the j notation.

j Notation



If we have two coordinates, i.e. an x axis and a y axis, all our vectors will start from the intersection of x & y at 0.

If the vectors are divided into their VERTICAL & HORIZONTAL components, then the addition of the vector quantities may be achieved by 1. Adding together all VERTICAL components
and 2. Adding together all HORIZONTAL components.

Confusion may arise with this method if errors are made and the horizontal components are accidentally added to vertical components. This can be easily avoided by identifying all VERTICAL components by placing the letter j in front of them.
Therefore, when we express the above vector, it will appear thus
4 + j2
i.e. the vector has a horizontal component of 4
and a vertical component of 2

From the intersection '0', vectors may radiate in all directions; this means that some vectors may be opposing others.
If you consider a tug of war between two equally matched teams, both are pulling on the rope with the same force, but in opposite

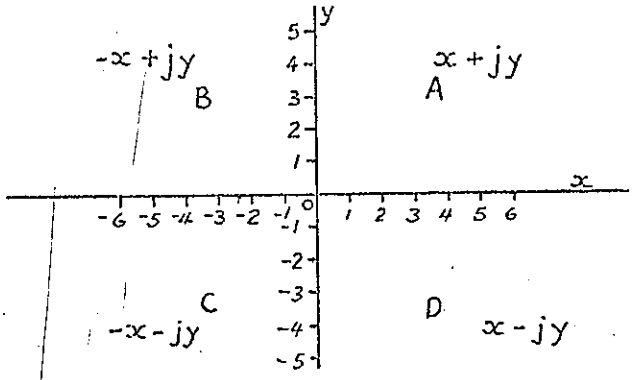
directions. The result is that the rope does not move.

4 lb ——————————— 4 lb

When the vectors are expressed, in the j notation method, the sum is $(4 + j0) + (-4 + j0)$

i.e.
$$\begin{array}{r} 4 + j0 \\ -4 + j0 \\ \hline 0 + j0 \end{array}$$ (no movement)

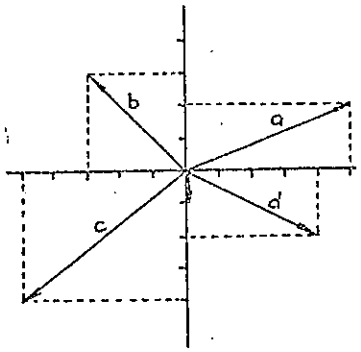
It can be seen then that vectors may have negative quantities. The graph shows where the negative quantities occur.



The + or - sign tells us the DIRECTION of the horizontal and vertical components of a vector.

Horizontal component is +, Vertical component is + in quadrant A
" " " - " " " + " " B
" " " - " " " - " " C
" " " + " " " - " " D

e.g. Find the sum of the vectors in the diagram.



$$\begin{array}{rcrcr} a & = & 4 & + & j2 \\ b & = & -3 & + & j3 \\ c & = & -5 & - & j4 \\ d & = & 4 & - & j2 \\ \hline & & 0 & - & j1 \end{array}$$

The resultant is a vertical line OA

Once the components of a resultant vector have been determined, actual values and angles may be calculated by Pythagoras or Trigonometry i.e.

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

$$\text{Tan } a = \frac{\text{opposite}}{\text{adjacent}}$$

In some electrical calculations, vectors will be used. It may also be necessary to multiply or divide vectors.

Multiplication & Division of Vectors

To multiply two vectors, say, 3-j and 2+j, it is necessary only to follow the basic rules of algebra.

$$\begin{aligned} (3 - j)(2 + j) &= 6 + j3 - j2 - (j)^2 \\ &= 6 + j3 - j2 - (-1) \\ &= 7 + j \end{aligned}$$

Note:- $j^2 = -1$

To divide vectors, we set out the problem - say $\frac{-2 + j4}{-4 - j2}$

The objective is to simplify the equation by eliminating the j component from the denominator. This is simply done by multiplying both denominator and numerator by the same components.

In our example, multiply top x bottom by -4 + j2. This is the same as the denominator except that the sign before the j component has been changed.

i.e. $$\frac{(-2 + j4)(-4 + j2)}{(-4 - j2)(-4 + j2)} = \frac{8 - j16 - j4 + (j)^2 8}{16 + j8 - j8 - (j)^2 4}$$

$$= \frac{8 - j20 + (-8)}{16 - (-4)}$$

$$= \frac{-j20}{20} = -j \text{ or } \underline{0 - j}$$

TITLE:- FITS, TOLERANCE & ALLOWANCE
LECTURER:- GERRY HENNIS
DATE:- 27-3-81
EQUIPMENT:-

Definition:- Fits, or the fit of the parts, may be defined as the degree of tightness, or looseness, between two pieces or parts, that are intended to act together.

Classification of Fits:-

In the assembly of any piece of machinery, the parts must be fitted together in correct relation to each other. Some parts may need to revolve, or move freely, while others must be fitted so that only slight movement, or no movement at all, is possible. It is therefore necessary to classify the various fits in some way, and the following list sets out the grouping and classes generally used:-

Group 1:- Clearance fits

Where there is a space between the two parts to allow for lubrication, freedom of movement and variations in temperature. The running fit is the main fit in this group.

Group 2:- Transition fits

These are where the parts are fitted together in such a way that no appreciable movement is possible, but not so tight that they cannot be dismantled when necessary. The classifications in this group are:-

(a) Sliding fit - Where the parts can be assembled by hand with slight pressure.

(b) Push fit - Much the same as sliding fit, but requiring a little more pressure to assemble.
Transition fits are not tight enough to transmit motion (or drive), and where this is required, the use of some fastening device, such as a key, or set-screw is necessary.

Group 3:- Interference fits

With these fits, no movement at all is possible after assembly, the inner part being definitely larger than that into which it fits. In increasing order of tightness, these fits are classified as follows:-

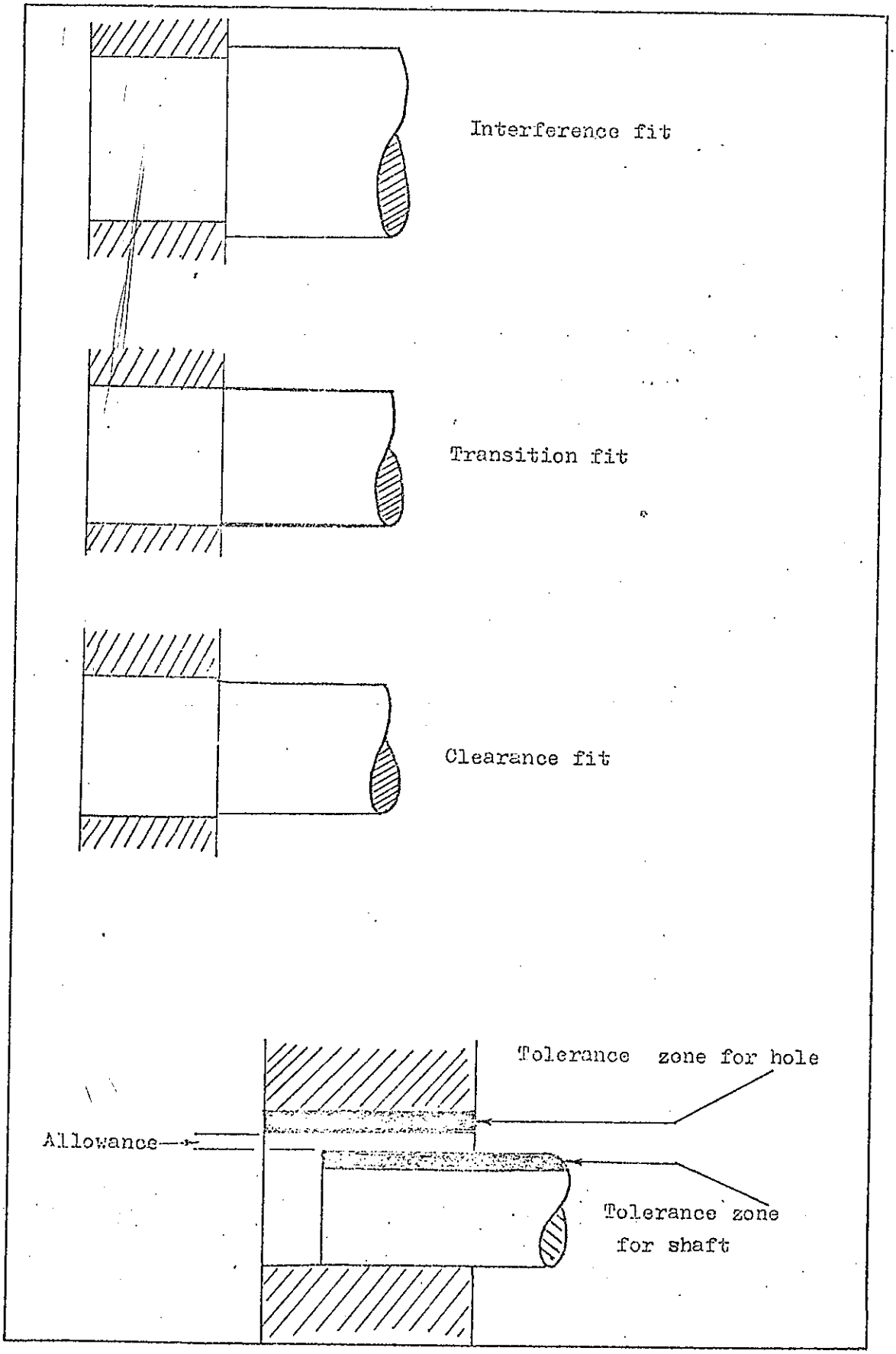
(a) Driving fit - Where the inner part is forced into the outer by sledge hammer blows, or by the use of a press.

(b) Forced fit - Similar to (a) but the parts are forced together by hydraulic pressure.

(c) Shrink fit - Where the outer part is expanded by heat and then forced on to the inner part, upon which it cools and in so doing, shrinks and grips securely.

Tolerance:- Variation of size permitted of mating parts.

Allowance:- The difference between the sizes.



TITLE:- TRAVELLING TO AND FROM WORK

LECTURER:- JERRY HEWINS

DATE:- 23-2-81

Generally speaking, because the greatest part of a person's life is spent at work, then it follows that a great deal of time is spent travelling to and from work. With few exceptions, starting and finishing times are standard, and that makes for 2 very distinct peak-traffic periods. The chances of having an accident during these periods are greatly increased, if only for the sheer weight of numbers. Add to this several other factors, then the potential of injury or death due to vehicular accident is very real.

Personal Condition - obviously, a person cannot hope to drive a car or ride a motor-cycle in a competent or safe manner, unless that person is in a fit and relaxed condition.

(a) Lack of sleep causes tiredness and drowsiness. As a result, full concentration and alertness is non-existant.
(b) Leave for work, giving enough time to arrive there without having to break speed limits. Statistics prove that the majority of "journey accidents" occur approximately 5 minutes before starting time.
(c) Leave personal feelings at home. Incidents which occur in the domestic scene, results in an angry and aggressive driver, who endangers all road-users.
(d) Relaxed and courteous drivers are a must for accident-free traffic.

Vehicle Condition - a vehicle which is in good condition and well maintained, will provide safe and reliable transport. Malfunction of any part of a vehicle, can be a hazard, especially in heavy traffic. Brakes, tyres, indicating lights, horn etc. should be functional. Winter presents another driving problem - fogged windscreens. Hose the windscreen down and wipe it clear before leaving for work.

Traffic Conditions

(1) Obey all speed limits.
(2) Leave earlier to avoid peak traffic.
(3) Avoid the "Pay-day Panic" situation - don't try and beat everyone out the gate. Wait a few minutes until the heaviest traffic has cleared.
(4) Don't drive or ride too closely to the vehicle in front - allow enough room in case of emergency.
(5) Motor cyclists should remember that they do not have the same protection as car drivers, and ride accordingly.

Journey Accidents - because journey accidents are covered by the Workers Compensation Act, there is a set procedure which should be followed, should a person be unfortunate enough to be involved in an accident.

(1) If possible, report immediately to the Medical Centre for treatment, however minor it may be.
(2) Notify the Security Department, giving details of the accident.
(3) Report for work, with Medical Centre approval.
(4) Because of injuries, it may not be possible to carry out the above - in that case, notification to the Medical Centre and Security should be done as soon as is practicable.
(5) Should a person be off work due to injuries received in a journey accident, a certificate of approval should be obtained from the Medical Centre before resuming work.

TITLE:- SIGHT PROTECTION

LECTURER:-

DATE:-

EQUIPMENT:- Safety glasses, welding masks, safety glasses with side shields, glggles, plain & tinted.

One of our most precious possessions is our eyesight. It is our ability to see what goes on about us, our families, friends, sport, television, nature etc.

What would it mean to you to live the rest of your lives in darkness. This is why eye protection is a very important part of Safety Training.

Eye protection equipment:- Many different types of equipment are available e.g. glasses, masks, shields etc. Be sure that you are wearing the right type of equipment for the job being done.
Ensure that safety glasses are comfortable and fit properly; most important - don't borrow anyone else's glasses.
Although the lenses are hardened, they are not immune to scratches, take care of them, store them in their case, and in your toolbox after work.
In case of loss, or breakage due to carelessness, the company reserves the right to charge for replacement.

Prescribed lenses:- If your eyesight is not normal, do not hesitate to see your optician, he may be able to prescribe glasses for you which can help prevent your eyesight deteriorating. Wearing glasses is a common sight today and you should not be embarrassed by wearing them. An optician visits the company every 6 weeks, and an appointment can be made by the safety department. Any prescribed lenses can be hardened and toughened by the optician.

Causes, and treatment for eye injuries:- A large percentage of eye injuries are caused by dust, scale,or foreign matter, and by other persons.
Should you be unfortunate to get something in your eye, the company has adequate facilities for treatment.
Don't rub your eye, or allow anyone to remove foreign bodies, only the doctor or qualified persons.
If acids or solvents enter your eye, wash out thoroughly with clean running water.
If anything damages the pupil of your eye, you could be left with the handicap of restricted vision.
A true saying is "Look out for your eyes and they will look out for you", and remember that it only takes a second to get something in your eyes, but it can cause many years of darkness.
Always keep this in mind whether at work or at home.

Eye Protection Areas:- Many areas around the plant have been designated eye protection areas. A notice is posted at all entrances to this effect, the Electrical Shop is one. In an eye protection area safety glasses must be worn at all times.

TITLE:- GOOD HOUSEKEEPING

LECTURER:- GERRY HEYNIS

DATE:- 24-2-81

EQUIPMENT:-

Good housekeeping is an essential part of our life. The majority of injuries are caused by bad housekeeping.

Tidiness:- Keep your work area tidy. If there is anything loose on the floor, whether it is in your vicinity or not, then pick it up and protect yourself as well as others.

Common Hazards:- are power cables and hoses over walkways, material not properly stacked, soap on shower room floors, untidy tools and toolboxes, oil etc. on the floor.

One of the worst offenders of housekeeping is the litterbug who delights in throwing his lunch papers and rubbish anywhere.

Facilities are provided for disposing of rubbish and anyone found abusing these or any other facility will be reprimanded.

Disease:- Apart from the obvious hazards of slipping on waste foodstuffs and peels etc., there is the less obvious hazard of disease carried by the vermin which is attracted to rubbish.

Workbenches:- The most important factor in good housekeeping is your own workbench which reflects your character.

Always keep tools and toolboxes tidy, don't have unprotected sharp points in your toolbox, don't hoard rubbish, clean up your work area with a dust pan and hand broom after completing each job. Deposit rubbish, scrap copper or scrap steel in the appropriate bins provided.

Spilled Oil:- When carrying oil cans etc., try not to trail oil over the floor. If you should spill any oil accidentally, or see any oil on the floor, cover it up with sand or sawdust.

Walkways:- Yellow lines indicate walkways, and must be kept clear of cables, hoses, materials and equipment. Always walk between the yellow lines; do not cut corners, or run. Do not cut corners, or run. This is strictly forbidden and offenders will be reprimanded.

You will save yourself a lot of trouble when you adopt clean habits and good housekeeping.

Don't forget that good housekeeping makes our job safer - keeps the standard high.

Each person is responsible for keeping the shop and work areas clean. Time will be allowed each day for this purpose.

M6/4/1

TITLE: GOOD HEALTH
LECTURER: Gerry Hennis
DATE:- 26-3-81
EQUIPMENT:

Why is good health the subject for a safety lecture? Health, bodily and mentally, have been proved to be very relevant in accident statistics.

Adequate Rest:- Any person who attends work who has had less than 7 or 8 hour sleep is a hazard to themselves and anyone around. Accidents are often caused by someone who is either sleepy or absent-minded. For this reason, we have always to be alert.

Personal Feelings:- Whenever you show anger, jealousy or hate, you become blinded to what goes on around you and become more accident prone.
Keep your mind on the job and let trouble ride until the whistle blows and the dangers around are not so great.

Habits:- To achieve satisfaction and give a good performance in anything, good habits must be an essential part of our lives.

Protection of Health

Wearing Masks:- Damage to lungs can be caused when working in dirty, dusty, smoky or gassy conditions. In these cases, appropriate face masks should be worn.

Barrier Cream:- We can protect our skin, firstly by applying barrier cream before starting work and secondly by wearing the appropriate safety equipment when working with or near acids, solvents etc.
Even using oil, copper, brass or having dirt or grease on your hands presents another health hazard - poisoning. Always wash your hands after touching these materials, and before eating.

Smoking, Alchohol and Drugs:- All three have a detrimental effect on health. All three must be resisted now, later may be too late. Alchohol and Drugs will not be tolorated at any time.

M6/5/1

TITLE:- REPORTING INJURIES
LECTURER:- GERRY HEYNIS
DATE:- 9-4-87
EQUIPMENT:-

Whenever accidents occur, injuries are usually suffered, whether large or small. All injuries incurred as a result of an accident must be reported, firstly to a supervisor, and then the Medical Centre. Failure to do so, could result in loss of entitlement under the Workers' Compensation Act.

In regard to minor injuries, the fact that it may be only a very small cut or bruise, should not act as a deterrent for receiving medical attention. All too often, a minor scratch develops into something more serious because the injury was not reported and medical treatment not received. Fear that they may be labelled a "sissy", deters many workmen from reporting for treatment for a minor abrasion.

Minor cuts and abrasions should be washed clean immediately. It should be then reported to a supervisor - giving brief details on how the injury was sustained. Treatment should then be sought at the Medical Centre.

More serious injuries, require immediate attention from a supervisor or a workmate, who should contact the Medical Centre direct or ring the emergency telephone number "00" and ask for assistance from Medical staff.

Injuries received outside of working hours can be treated at the Medican Centre, although, obviously, they are not covered by the Workers' Compensation Act. By reporting for treatment, the risk of aggravation to the injury is lessened, and a workman can carry out his job without restrictions.

TITLE:- WHAT TO DO IN CASE OF ACCIDENT - BASIC CARE OF INJURED.

LECTURER:- JERRY HEYNIS

DATE:- 9-4-91

EQUIPMENT:-

First aid is the emergency care of the injured or the sick, and it is based on current medical and surgical principles. Although this lecture is not intended to be a first aid course, it is meant to show the basic principles.

First aid begins immediately the first aider arrives on the scene, and continues until the casualty is attended to by a doctor, removed to hospital, or has fully recovered. It enables persons trained in first aid to give such assistance as will -

(a) Preserve life
(b) Promote recovery
(c) Prevent the injury or illness from becoming worse.

Golden rules of first aid:-

(a) Rapidly asses the situation (look for danger i.e. gas, fire, vehicles, etc.).
(b) Remove the cause or remove the casualty.
(c) Act with quiet confidence (don't rush around - be calm).
(d) Check the pulse (refer to resuscitation lecture).
(e) Check for breathing (" " " ").
(f) Control any haemorrhage (direct pressure).
(g) Asses the state of consciousness (response to touch, command, pain).
(h) Give injuries priority according to severity.
(i) Reassure the casualty.
(j) Handle the casualty gently.
(k) Remove clothing only if necessary.
(l) Arrange for the disposal of the casualty (ambulance, doctor etc)

The scope of first aid:-

To make a diagnosis.
To decide the nature and extent of the treatment required.
To arrange for the disposal of the casualty.

Diagnosis:- The first aider must consider the HISTORY, SYMPTOMS & SIGNS from which the case will be diagnosed.

History:- The history is the story of an accident or illness, that may be obtained from -

The casualty
The witness
The evidence of the surroundings -

It could indicate that a person is subject to a particular disease, or the surroundings may suggest the cause e.g. a crash scene.

Symptoms:- Symptoms are the sensations the casualty describes e.g. pain, faintness, nausea, thirst.

Signs:- The signs are differences from normal, which can be detected by the first aider, e.g. pallor, raised temperature, rapid pulse.

Treatment

Commence treatment necessary to:-

Sustain life, by restoring circulation/respiration
Control bleeding (direct pressure)
Lessen shock (keep patient warm)

Prevent the condition from being aggravated by:-

Covering wounds (sterile dressing)
Immobilising fractures (splints)
Posturing the casualty (i.e. coma position)

Promote recovery by:-
Reassurance
Relief of pain
Gentle handling
Protection from the weather.

Glossary

Casualty:-	Victim of illness or accident.
Pulse:-	The heart beat.
Diagnosis:-	Naming the illness or injury suffered.
Nausea:-	Feeling of sickness.
Circulation:-	The movement of blood through the body.
Respiration:-	Breathing.

TITLE:- RESUSCITATION

LECTURER:- GERRY HEYNIS

DATE:- 6-2-81

EQUIPMENT:- Resuscitation mannikin

The need to apply resuscitation may arise at any time, as a result of many causes. The most common of these are:-

Electric shock
Heart failure
Airway obstruction
Drowning
Poisons (including gases)
Head & chest injuries.

Any one of these may -

Stop the breathing (Respiratory arrest)
Stop the heart (Cardiac arrest)

The breathing may be stopped, yet the heart may continue to beat for a short period;

But if the heart is stopped, then the breathing will stop almost immediately.

If either respiratory arrest, or cardiac arrest, then immediate action must be taken to resuscitate the patient. Otherwise, irreversible brain damage will occur, due to lack of oxygen. After only 2 minutes without oxygen, there is some chance of brain damage. After 4 minutes without oxygen, there is certain to be serious brain damage.

When rescuing and resuscitating a patient, there are 5 main steps to take:-

(1) Don't be the next victim
Beware of active sources of danger, such as electricity or toxic gas.

(2) Separate the cause of the accident from the patient
It is preferable to remove the cause from the patient. If this cannot be done, then remove the patient from the cause.

(3) Open the patient's airway
Tilt the head well back and pull the jaw forward. This clears the tongue from the airway. Quickly clear any solid material from the mouth and throat. Opening the airway may cause the patient to breathe spontaneously. If this does not occur, then continue as follows.

(4) Ventilate the lungs
With the patient on his back, kneel beside the head. Hold the head in both hands, one pressing the head downwards and backwards, and the other pushing the lower jaw upwards and forward. Time is vital, therefore the first 3 or 4 inflations should be given as quickly as possible.
For continued artificial respiration, inflations should be at a rate of 10 per minute for an adult. If the chest does not fill with air, check the airway and check the airseal of your mouth over that of the patient.

(5) Cardiac Resuscitation
After giving the patient 3 or 4 quick breaths, check to see if the heart is beating. Absence of heart beat (cardiac arrest) will be indicated by:-
UNCONSCIOUSNESS:
CYANOSIS: (a blue colouring) which appears about the lips, earlobes, face and the whites of the eyes.
Alternatively, the patient's colour may be very pale.
ABSENT PULSE: Check the carotid pulse. Pupils (the black spot) of the eyes widely dilated.
ABSENT RESPIRATION:
If cardiac arrest has occured, then immediate cardiac resuscitation TOGETHER WITH mouth to mouth resuscitation must be carried out, using the following technique:-

(a) With the patient on a firm surface, kneel at the side of the patient's chest.
(b) Feel the chest and locate the lower half of the sternum (breast bone).
(c) Place only the heel of one hand on this part of the bone, keeping the palm and fingers raised from the chest.
(d) Cover this hand with the heel of the other hand.
(e) With the arms straight, rock forward over the patient, until the shoulders are vertically above the hands and press briskly down on the sternum.
In an unconscious adult, the sternum may be depressed 1½" - 2" (40 - 50mm).
(f) Rock backwards, releasing the pressure, but maintain contact with the sternum.
(g) Constantly check the tilt of the head, to ensure that the airway remains open.

Rates of application:-
Adults - 60 compressions per minute.
Children & infants - 90 compressions per minute.
When applying cardiac resuscitation to a child, use only one hand.
For an infant the pressure of two fingers is sufficient.

Ratios:-
Using 2 operators -
1 lung inflation to 5 sternum compressions. (un-interrupted cycles)
Using 1 operator -
2 lung inflations to 15 sternum compressions.

Risks of cardiac compression:-
Pressure ill applied or excessive, can cause damage to the rib cage or underlying organs. However, when cardiac compression is well carried out, the risk is much less.

Check the effectiveness of cardiac compression by:-
Watching for improvement in the colour.
Checking the presence of the carotid pulse.
Noting the size of the pupils.
When the pulse returns, cease cardiac compression but frequently confirm that the pulse is still present.
If the pulse does not return, continue treatment until advised otherwise by competent medical personnel.

RECOVERY:-

assisted breathing - as the patient begins to respond, his attempts to breathe may be weak and intermittent. In such case, continue mouth to mouth and co-ordinate the resuscitation, with the patient's attempts to breathe.

Vomiting may occur as the patient recovers. If the patient is lying on his back, vomitus will be inhaled causing airway blockage. This can be prevented by placing the patient carefully into the coma position as soon as he is breathing spontaneously.

KEEP THE PATIENT WARM:

Any person who has been injured, suffers from shock, and it is therefore important to retain body heat - but do not overheat the patient.

Remember:- Airways
Breathing
Circulation

TITLE:- INDUSTRIAL & DOMESTIC GASES

LECTURER:-

DATE:-

EQUIPMENT:-

Liquefied Petroleum (L.P.) Gas

L.P. gases such as those marketed locally under trade names such as Handigas, Portagas etc., may contain one or more of the hydro-carbon gases such as Propane, Butane, Propylene.
This gas is almost twice as heavy as air, and should it escape from a cylinder or tank, it will tend to settle in low places. It may collect in a hollow, or at the bottom of a confined space before it can dissipate into the air. The gas does not readily dissipate unless there is appreciable wind velocity.

A mixture of air and L.P. gas is highly dangerous and may ignite or explode. Should such a spillage occur, water jets should be used over the area to fully disperse the spilled liquid and/or gas.
Whilst an escape of L.P. gas represents some hazard, an escape of liquid is an even more serious matter. This is obvious when it is realized that one volume of liquid represents about 270 volumes of gas. The potential volume of flammable mixture which would be released to the atmosphere, from a liquid spillage is enormous.

L.P. gases are considered to be non-toxic. However, where high concentrations exist, there could be a deficiency of oxygen. The prolonged breathing of high concentrations of L.P. gas can cause dizziness and symptoms similar to intoxication.

L.P. gas has little or no smell, and so that leaks can be quickly detected, an odour is given to the gas by an addition of a stenching chemical. However, since L.P. gas is heavier than air, leaks can go undetected, if the point of leakage is below head height. All L.P. gas is required to be odorized. Should supplies of L.P. gas be found not to have the characteristic smell, they should not be used, but should be returned to the supplier.

It is important to understand the behaviour of L.P. gas in closed containers.
The lower section of the container, whether it be bulk tank or cylinder, holds the liquid, and the upper section holds the vapour. As the boiling point of propane liquid, for example, is minus 44°F at atmospheric pressure, whenever gas is withdrawn and used from a propane cylinder in service, the remaining liquid rapidly vapourises, until the vapour pressure of the gas and liquid within the cylinder reach equilibrium.

Liquid L.P. gas evaporates readily under atmospheric pressure, absorbing heat from its surroundings. It will freeze the hand on contact, even through gloves.

OXYGEN:- This is an odourless, colourless gas. It does not burn itself, but it supports combustion, ie. materials which burn sluggishly, in ordinary atmosphere, will burn vigorously in oxygen enriched atmosphere.
Likewise, materials which burn readily in atmosphere, will burn very vigorously in the presence of oxygen. The primary hazards in working in the presence of oxygen, are fire and explosion, but, fires or explosions cannot normally occur, without the following factors being present:-

(1) The igniter
(2) The material for combustion
(3) The oxident.

A constant watch must be maintained to control these factors.

(1) The igniter:- Any source of heat or combustible material, must be considered as a possible igniter in the presence of oxygen. Some examples are:-

A naked light.
A lighted cigarette.
A cigarette which has been extinguished but is still warm.
Sparks or heat, caused by impact of materials.
Sparks or molten metal from flame cutting.
Molten weld metal or heat from metal after welding.
Frictional heat or heat from an electrical fault.
Heat from a soldering iron.

(2) The material for combustion:- It is impractical to set down a complete list of combustible materials, but is feasible to state two classifications for general guidance.

(Class 1) Combustible gases
Acetylene
L.P. gas
Combustible liquids that vapourise at room temp. - petrol etc.
Porous combustible materials
Oils & Greases

(Class 2) Materials which may ignite easily
Wood - wood shavings
Asphalt
Paint
Cotton waste
Clothing

Oxygen must never be used as a substitute for air, i.e. compressed air.

(a) Oxygen lines must not be attached to pneumatic tools, there is a distinct possibility of the tool exploding, or bursting into flames, on contact of the oxygen with the lubricated parts.
(b) Oxygen must not be connected to spray guns.
(c) Oxygen must not be used to blow dust from areas.
(d) Never use oxygen to dust down clothing.

Acetylene:- Acetylene cylinders contain porous material, which is impregnated with acetone; the acetylene is dissolved under pressure in the acetone. The cylinder must be kept upright to prevent the acetone from clogging the regulators, thus impairing the flow of gas. Backfires and flashbacks can result from this condition.

Backfire - this is a momentary extinguishment or momentary burning back of the flame into the blow pipe tip or nozzle. It is caused by touching the tip against the work, by particles entering the tip and obstructing the oxygen or acetylene flow or by overheating the tip. Sometimes the trouble will clear itself immediately. If this does not happen, close the blowpipe valves.

Flashback - this is the burning back of the flame, into the blowpipe or the ignition of an explosive mixture in one of the oxygen or acetylene lines. A flashback can burn right back into the tubing. The danger in the case of a flashback can be practically eliminated, by understanding immediately what it is and what steps to take.
In the case of flashback into the blowpipe, a flame burns at the mixer with a shrill hissing sound.
The blowpipe oxygen valve should be closed immediately, followed by the closing of the acetylene valve. Wait a few moments to be sure that the flame inside the blowpipe has a chance to burn out.
Should flashback occur into the tubing, close the cylinder valves immediately. Flashbacks can be caused by improper pressure, distorted or loose tips, kinked tubing, clogged tip or over-heated tip or blow pipe.
The following are the standard colours of gas cylinders supplied to the works:-

GAS	COLOURS
Acetylene	Maroon
Air	Black top - dark grey body
Argon	Peacock Blue
Argon & CO2	French grey top - peacock blue body
Carbon dioxide (CO2)	French grey
Chlorine	Golden Yellow
L.P. gas	Aluminium
Nitrogen	Dark Admiralty Grey
Oxygen	Black
Hydrogen	Bright red

TITLE:- DANGERS OF PRACTICAL JOKES

LECTURER:- GERRY HENNIS

DATE:- 6-3-81

EQUIPMENT:-

Not too many years ago, industry was affected by the twisted mentality of some workers, who delighted in inflicting suffering and torment on fellow workers. Their actions came to bear the name of "horseplay".

Horseplay is things like rough fooling on the job, pushing, shoving, tripping, pulling another's clothing, knocking their hat off etc. It's playing tricks on a person to make them look silly or feel bad or upset.

The worst horseplay was directed at new starters on the job - to see how green they were.

Most people on their first job are a little confused and it is easy to fool them. Some people get a great deal of pleasure out of playing jokes on new workers; there is a word for it - Sadism. A sadist is a person who enjoys seeing someone else suffer.

"Goosing" is another form of horseplay. Goosing means a jab in the sensitive part of the body. A number of workers have been killed by being "goosed" with an air hose. Of course, most horseplay isn't nearly as bad as that. Most fellows enjoy a bit of roughing around, but, in a plant, horseplay can, and often does, cause accident and injuries.

Pushing a fellow or even tripping him might not be too bad on the beach, but in the plant, it is too dangerous. There's too much machinery around, too many things to bang into and the floor doesn't give when one's back or maybe his head lands on it.

Safety minded management does not stand for horseplay; it brings too many injuries.

Safety and horseplay don't mix. Safety is a serious business, it saves life and prevents suffering.

Horseplay is old-fashioned and unsafe. Don't do it.

TITLE:- PROTECTIVE CLOTHING

LECTURER:

DATE:-

EQUIPMENT:- Safety helmet, gloves, face shield, goggles, ear muffs, ear plugs

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Employees who work in the presence of molten metal, or in welding and cutting operations, should be aware of the hazard of synthetic work clothes. An incident occurred recently where a man, wearing polyester trousers, had the legs burnt off them.

While synthetic materials are cheap, cool and readily available, they are not suited for many operations throughout the steel industry. Garments with high woollen content or wool-cotton content, are the most suitable. This type of clothing has a longer life and has not the fire risk of the synthetic clothing.

Safety Helmets:-
These are manufactured to very rigid specifications and a series of tests are carried out on a set of helmets from each batch.

Electrical insulation resistance test
The helmet is supported by a wire frame and filled with a solution of sodium chloride. A voltage is applied (2,000Vr.m.s.) between the wire frame and the sodium chloride. The helmet tested must not show a leakage current in excess of 3 milliamperes.

Conditioning:-
The test helmet is then submitted to the following conditions -
1. At a temperature between 18°F and 22°F for 4 hours in a refrigerator.
2. Temp. of 122°F for 4 hours in an oven.
3. Immersed in water at room temperature for 4 hours.

Stiffness test:-
The helmet is set in a compression testing machine; a load of 20 lb. is applied slowly, and the deformation of the shell is measured to the nearest 0.01 in. and it is not to exceed .5 in.

Shock absorption test:-
The helmet is placed over a wooden heat form. Under the head form is a strip of aluminium with a small ball bearing on it. An 8 lb. ball is dropped a distance of 5 ft., applying a force of 40 ft./lbs. directly on the centre of the helmet. The size of the impression made on the aluminium, by the ball bearing, determines if the helmet is up to standard or not.

Penetration test:-
For this test, the helmet is placed on a wooden head again. A 16 oz. plumb bob, with a steel point, is dropped 10 ft. The harness is not to break and the shell is not to fracture, dent, or be pierced to a depth of more than $\frac{3}{8}$".

Flammability test:-
A specimen is cut from the thinnest part of the helmet and is dried in an oven for 5 hours, and then conditioned in a chamber for 48 hours. After this it is held over a gas burner for ten seconds. The specimen is not to burn at a greater rate than 3 inches per minute.

Gloves:-
A selection of gloves, suitable for all types of work, is available at all times. The most used type of glove in our shop is the rubber glove, which is used every day, because the de-greasing solvent removes natural oils from the skin, which leaves them dry and subject to cracking, which leaves the skin open to infection.

Protective clothing for welding:-
Wear goggles with prescribed lenses, to protect the eyes from sparks, flying slag and injurious rays.
Wear anti-flash equipment.

For welding with oxy-acetylene, wear apron, leggings, gloves and goggles.

Grinding operations:-

It is forbidden to wear gloves while grinding:-
Many injuries have occurred, because of gloves jamming between the wheel and wheel rest. If any circumstances arise, in which it appears that the wearing of gloves would be advisable, then you must contact your supervisor and obtain permission. The same rule applies to wearing gloves while operating any type of machine tools i.e., lathes, milling machines, boring mills, drills etc.

The following regulations apply to protective clothing which must be worn in the structural mill and finishing end.

Pneumatic drills, chippers:-
Gloves, goggles and safety helmet.

Mill hands:-
Safety helmet and gloves.

General wearing apparel:-
All employees are required to equip themselves with suitable and adequate clothing. The minimum requirements are long trousers and shirt. Shorts are not suitable. Employees working in the vicinity of moving machinery, shall wear close fitting clothing. Machinists who must pass their arms over revolving stock or chucks, shall wear short sleeves. The wearing of light shoes, sandals, sandshoes, desert boots etc. is prohibited. In the steel industry, sound footwear is essential. Safety boots and shoes are recommended and can be purchased through the company at below cost price.

Hearing protection:-

Millions of people could suffer sever hearing problems, and other ailments from everyday sounds. Even the sound of a balloon bursting could be damaging.
The level at which noise becomes dangerous depends on how loud it is, how long we are exposed to it, and how close we are to its source. The comparitive unit of sound strength is the DECIBEL. The value chosen for 1 DECIBEL, is the sound which can just be discerned by the trained ear.
The sound of a balloon bursting, could burst an ear drum if it occurred in a confined space. The noise emitted by 4 or 5 loud typewriters could reach 85 decibels. Excessive sound - such as sirens - could also raise blood pressure and cause nervous tension. Some sections of the plant require ear protection to be worn, i.e., motor rooms. The following is a list of hearing protectors, supplied by the Company:-

1. Safety cap and muff combination
2. Banded ear muff
3. E.A.R. (foam plastic) plugs
4. Bilsom's (wool) plugs.

TITLE:- HAZARDS WHEN USING SOLVENTS
LECTURER:- Gerry Heynis
DATE:- 27-3-81
EQUIPMENT:-

Solvents are usually encountered in battery and plating rooms, chemical degreasing, metal cleaning baths etc.
Most of the chemicals are corrosive, and in a liquid state.

(1) Rubber gloves and clear goggles should be used.
(2) Suitable artificial or natural ventilation is essential.
(3) First aid material should be readily available.
(4) CYANIDE is present in some case hardening materials.
(5) Toxic gases are given off by numerous cleaning and degreasing agents, so respirators should be worn when working for long periods under these conditions.
(6) Skin dermatitis often occurs from continuous working with plastics, paints, solvents, etc. Regular application of barrier cream is advantageous.
(7) Low voltages are more dangerous when the body resistance is lowered by contact with metallic salt solutions.

First aid Treatment

Corrosive Burns:- This type of burn often occurs in battery, electro-plating, and metal cleaning workshops.
Acid Burns:- Wash in running water to dilute, then wash in a solution of soda (baking soda) and warm water.
Alkaline Burns:- Wash in running water to dilute, then wash in a solution of acid lotion, i.e. vinegar, lemon etc., and water.
Cyanide Poisoning:- This action is extremely rapid, and treatment should be given instantly.
The symptoms are:- Giddiness, staggering, insensibility, convulsions, panting respiration.

Treatment:- Artificial respiration, even if breathing has NOT ceased.
If patient is conscious and can swallow, give sal volatile or brandy etc. in water.
Dash cold water on the head and spine continuously.

TITLE:- FIREFIGHTING

LECTURER:

DATE:-

EQUIPMENT:

In the event of a fire, bring into operation the emergency equipment available. If the fire appears to be beyond the scope of the equipment, or vital plant is involved, dial 00 and give the following information:-

(1) State the location of the fire accurately.
(2) Give brief details of the fire, e.g. electrical, oil fire, or building.
(3) Do not hang up until the person receiving the call has checked back that he understands the message.

Fire extinguishers are the first line of defence. There are four standard types on the Whyalla plant - Water extinguisher, Foam, Dry Powder and Carbon Dioxide. Each type has its special purpose and for efficient control of a fire outbreak, the correct extinguisher should be selected from the fire board.

Pressurised water extinguisher:-
This is simply a stainless steel container of water charged with compressed air, and, when operated, the water is forced through the hose by the pressure of the air inside. The prime function of this extinguisher is fires in wood fibre, paper etc. It MUST NOT be used for electrical fires.

Foam extinguisher:-
Foam is a chemical, reproduced by the reaction of two solutions; one in the extinguisher shell, and the other in an inner container. By turning the extinguisher upside down, the solutions mix and produce CO2 gas, and discharges the foam up to a distance of 25 ft. The foam clings to the surface of the liquid, forming a thick, smothering and cooling blanket. The prime function of this type is for liquid fuel fires, or small surface fires, and MUST NOT be used for electrical fires.

Dry powder extinguishers:-
These are ideal units for extinguishing fires in inflammable liquids and live electrical equipment, where dust or residue is not a problem. They are not as effective on wood or similar fires as the water type. The extinguisher is filled with dry chemical, which is non-corrosive, non-conducting and non-abrasive. It is pressurized with dry nitrogen or CO2. When operated, the powder stream, which besides smothering the fire, absorbs and reflects heat, allows the operator to move closer to the seat of the fire.
The powder is non-toxic, but care must be taken not to inhale excessive quantities, as it has a partial suffocating effect and is a slight irritant. Keep a sharp watch for "Flashback", which occurs when the powder has not completely covered the area, or the ground temperature is greater than the flash point of the fuel, and re-ignition takes place in the area.

Carbon dioxide extinguishers:-
These contain carbon dioxide under pressure, which is released, by operating the squeeze-grip valve, and is directed to the fire, through a specially designed discharge horn.
Carbon dioxide extinguishes fires by smothering, and being a non-conductor of electricity, can be safely used on fires involving live electrical equipment. It can also be used on small fires of other natures.
The discharging cloud of gas should be directed into the equipment, from a position where the gas can enter and permeate through the body of the motor, cabinet, cable run etc.

With carbon dioxide extinguishers, the effective stream range is limited to 4 to 5 ft.

It is necessary to approach an electrical fire as near as possible, to effectively discharge the carbon dioxide extinguisher.

The distinguishing colours of the various extinguishers are:-

B.C.F.	Yellow
Dry Powder	Orange
Water	Red
Foam	Blue

TITLE:- USING ELECTRICAL OR C/A TOOLS AND MACHINES; WORKING AROUND MACHINES.

LECTURER:-

DATE:-

EQUIPMENT:- Nil

Every machine has its hazards, when operating, and they cannot always be realised.
The following are points to follow when operating machinery.

Guards
Switch off the main switch before removing any guards, replace them immediately you have finished.
Remove Plugs when making alterations to portable machines, they can start inadvertently. The same applies for air driven machines.
Isolate and attach out of service tags when overhauling or making adjustments to a machine.
Before starting a machine clear the working area of rubbish and materials.
Be sure that you know how to operate and stop the machine quickly.
Remove chuck key.
Secure workpiece onto the work table, into chuck or in the vice.
When sure you have full control over the machine, especially with regards to speed and feeds and ask for assistance if you cannot handle the machine alone.
Only the operator is to move control switches and levers.
Wear the correct protective equipment, such as safety glasses, goggles, face shields, hairnets, overalls, and ensure that they fit properly, especially overall cuffs.
Never wear gloves
Cables and hoses are not to be laid over walkways. If walkways can't be avoided, the cables or air hoses should be covered by rubber mats.
Couplings on C/A (Compressed Air) hoses should be wired together after coupling, to prevent splitting under pressure. The free end of C/A lines should be secured before the air is turned on.
Release the pressure in a C/A line before disconnecting.
When using any machinery which is liable to give off sparks or chips erect shields to protect others.
Never indulge in horseplay, sky-larking, or play practical jokes on people operating machinery.
Talking only interrupts your concentration whilst working, therefore it is forbidden.
When using grinders, do not use excessive pressure and use the correct type of wheel for the material being worked.
Treat all machine parts and rotating shafts with respect.
Never try to oil, polish, clean or adjust any moving parts or shafts.
Static Electricity:-
Almost all rotating parts generate static electricity. Certain combinations of clothing such as wool and silk also generate static which can charge your hair. Put the two together and you have the ingredients for a scalping.
On completion of work:-
Let the machine slow down and stop alone, don't use your hands.
Clean up shavings using a hand broom.
Replace all equipment and material where it belongs.
Should you have any ideas for improving safety don't keep them to yourself.
Always follow all rules or warnings regarding safety.

TITLE:- HAZARDS OF WELDING

LECTURER:-

DATE:-

EQUIPMENT:- Welding shield, gloves, goggles, flint gun.

Working on tanks & containers:-

Welding or cutting of containers such as drums, barrels, or tanks, is only to take place under direct staff supervision. Don't depend on your eyes, or sense of smell to decide if it is safe to weld or cut a closed container. Very small amounts of residual gas or liquid can cause a serious explosion.

(A) When you know the container held a gas or liquid, which will dissolve in water:-
  (1) Flush out with water several times, and then fill with water as far as work permits, positioning the container, to permit introduction of as much water as possible.
  (2) Before welding or cutting, be sure there is a vent or opening, to provide for release of air pressure, and request your foreman to inspect before commencing.

(B) When you know the container held a gas or liquid which will not dissolve in water:-
  (1) Clean out thoroughly with steam, or a cleaning agent, and fill with an inert gas, such as carbon dioxide or nitrogen before repairing. Carbon dioxide is heavier than air, and will tend to remain in the container if the opening is at the top.
  (2) Use steam to clean out light materials.
  (3) Use a strong caustic soda solution, to clean out heavy oils and grease.
  (4) Be sure to fill with inert gas, no matter how well you have cleaned - there may still be traces of oil, grease, or other readily oxidisable material under seams.
  Be careful when cleaning with steam or caustic soda - wear goggles and gloves. Don't clean where there is poor ventilation.

Fire Prevention:-

The oxy-acetylene or handi-gas flame, is rarely in itself the cause of a fire. Sparks, which fly from welding or cutting work, are really little balls of flowing metal oxides. They can travel a considerable distance from the point of origin, and they may stay hot for some time after landing.
When it is necessary to weld or cut against, or near wooden walls, floors etc., shield it with wet asbestos and sheet metal. If cutting over a wooden floor, wet the floor thoroughly before commencing. Do not use wooden horses or boards, to support welding or cutting work. Clean the area of rubbish and all inflammable materials before starting.
If you cannot reasonably remove the materials 25 ft. away, shield it with an asbestos blanker and have appropriate fire extinguisher handy. Watch particularly for petrol, oil, oil drums and inflammable gases in the vicinity of welding and cutting work.

Personal Safety:-

(a) Maintain your equipment in good condition.
(b) Wear goggles with prescribed lenses when using a blow-pipe; they protect your eyes from sparks and flying slag, from strong light and injurious rays of the flame; they also help you to see better.
(c) Wear suitable gloves, aprons, gaiters, shoes and other protective clothing applicable.
(d) Never use oxygen to dust down clothing or work.
(e) Use a flint-gun to light the blow-pipe - never use matches.
(f) Clear all inflammable materials from the area, before welding or cutting.

(g) Keep flame, sparks and hot metal, away from cylinders and hoses.
(h) When working on any objects, containing metal that gives off toxic fumes, always use a suitable respirator, and/or work in a well ventilated area.
(i) Manilla rope stagings are not to be used, for welding and cutting jobs.

If an acetylene cylinder is heated accidentally, or becomes hot through severe flash-back or other cause, action should be taken promptly as follows:-
(1) Shut the cylinder valve if possible.
(2) Clear all personnel from the area.
(3) Cool the cylinder with plenty of water, from a protected vantage point.
(4) Notify your foreman.

Cylinders must never be used as supports or rollers, or dropped indiscriminately from vehicles.
Under NO circumstances must oxygen be used as a substitute for compressed air.

TITLE:- LADDERS & SCAFFOLDING

LECTURER:-

DATE:-

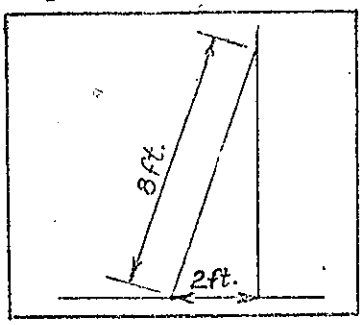
EQUIPMENT:- Body belt, ladder, hand line.

Safe use of ladders:-

(1) Use only an unpainted ladder and inspect the grain for damage, check for loose rungs and frayed ropes.
(2) Don't use a ladder with reinforcing wire along the rails, when working near "live" conductors.
(3) Have only one person at one time on a ladder.
(4) If you must erect a ladder near a thoroughfare or doorway, station a man at the ladder.
(5) Don't construct a makeshift ladder.
(6) All ladders must stand NOT LESS than 3'6" above any staging.
(7) Do not throw tools, material etc. to anyone working on a ladder (use a hauling line).
(8) Carry all ladders in the horizontal position.
(9) Beware of loose tools, material etc. on trestles or step ladders when moving to another position.

To help prevent ladders from slipping:-

(1) The ladder should be provided with non-slip rail ends
(2) It should be positioned securely and be sure that the base is set out from the wall at approximately ¼ the length of the ladder.
(3) A ladder should be secured by lashing or blocking, or have someone hold the base steady.
(4) Never place a ladder in front of a door that can be opened towards it.
(5) Never lean a ladder against unstable backing.



(6) A ladder should never be placed against a window pane or sash.

To help retain balance:-

(1) Always face the ladder when going up or down.
(2) Grasp the rails or rungs and be sure that you have a good hold with one hand, before releasing the other.
(3) Clean mud, grease etc. off your shoes and ladder.
(4) Never reach out further than an arm's length.
(5) Never try to slide down a ladder.
(6) Never go higher than the third rung from the top of a straight or extension ladder, nor higher than the second step from the top of a step ladder.
(7) Do not carry tools or material up or down a ladder - a hand line should be used.
(8) Don't use makeshift ladders.

Scaffolding regulations:-

(1) The height of the working platform, of any mobile stage above ground or floor level, shall not exceed three times the least width of the base of the stage.
(2) The minimum width of the working platform shall be not less than 3'9".
(3) A working platform shall be provided with hand rails (fibre rope must NOT be used for hand rails).
(4) No person shall remain on a mobile stage while it is being moved.

(5) The wheels of a mobile stage, are to be wedged or locked, to prevent movement when in the working position.
(6) It is necessary to fence, or otherwise make safe, all working places, from which a person could fall a distance of more than 8 ft.
(7) A safety belt and lifeline should be used on a sloping surface.
(8) All planks used on staging must be lashed, cleated, or otherwise secured, to prevent displacement.