IJA # 3728

Archival Material from the Shamash Secondary and Frank Iny Schools Including Class Notes, Examinations, and Translations

The word "radical" although often used in this loose sense, actually means an assembly of atoms that behaves as a unit and possesses as its most charact eristic feature an unpaired electron thus a methyl radical $cH3^{\cdot}$ or H. These radicals are very reactive . e.g. nascent hydrogen $H^{\cdot}$ which possesses one electron in its outer shell this electron tends to pair up with another electron to form e.g. H:H which is hydrogen gas or other compound.

ORGANIC GROUES: The term methyl groupp , as ordinarily employed, refers to a CH3 assembly which is covalently bonded to some other atom in tthe molecule

NOMENCLATURE:

We have three types of naming the organic compounds :

(1) Derived name : An organic molecule is named as a substitution product of the first member of the family to which it belongs . e.g. methyl chloride CH_3Cl

The most highly sub stituted carbon atom is considered the carbon atom of the parent " methane molecule and the hydrocarbon is named by indicating the groups in order of size which are attached to this carbon atom.

e.g. neopentane may be considered to be derived from methane by replacement of the four Hydrogen atoms by methyl groups and it is therefore called "Tetramethylmethane"

Note: The derived name is always a single name and no commas or hyphens are used to separate the groups unless the groups themselves require such punctuation.

(2) To use a common name: we use the name that has no relation to structure

e.g. methane , acetylene, ...

(3) I.U.C. Name : This is the most important method of naming and it is the official system of monenclature.

Because so many isomers are found for every molecular formula, and because of the difficulty of naming them by the old method (which used the common names) The international Commission of chemists which met in Geneva Switzerland in 1892 studied this problem . Then a system was created for nomenclature and this system was ;ater improved and extended many times ., Lastly in 1958 by the international union of pure and applied chemistry. This method of monenclature is called the I.U.P.A.C. or siply the I.U.C. system.

RULES USED IN I.U.C.NAMING: for open chained alkanes,

1- the compound is named as a derivative of that hydrocarbon which corresponds to the longest continuous chain of carbon atoms in its formula.

2- The carbon atoms in this chain are numbered consecutively from one end to the other , either right to left or left ot fight , in order to designate the positions of the substituent groups by the smallest possible figures.

3- The position of each branching alkyl group is specified by the number of carbon atom to which it is bonded in the parent

4- The nUmber designating the position of each of the various usbstituent, groups on the main chain is placed before the name of the substitient group in question and separated from that name by a hyphen .If there are several identical substituent groups present, their numbers are listed together , commas separate such numbers and a hyphen (-) is used to seperate the last of the listed numbers from the appropriate prefix ,di-, tri-, tetra, indicating how many of the identical substutuent groups are present.

5- The name of the alkane is written as one word with numbers and names of the substituent groups including the appropriate punctuation, serving as a prefix to the name of the basic chain . The substituent groups may be listed in alphabetical order or in the order of increasing size.

Example of nomenclature:

$$\begin{array}{l} \qquad CH_3 \\ CH_3-C-CH_2-CH-CH_2-CH-CH_3 \\ \qquad CH_3 \qquad\quad C_2H_5 \quad CH_3 \end{array}$$

(1) The longest continuous chain is the 7-carbon chain . Therefore the basic name is heptane

(2) The heptane chain is numbered consecutively from left to right rather than vice versa. When the heptane chain is numberd from left to right, two of the methyl groups , rather than one are joined to the second carbon atom.

(3) There will be a total of four individual numbers in the final name. The methyl groups are located at positions 2,2, and 6 of the heptane chain and the ethyl group is found at position 4.

(4) The positions and names of the substituents are assembeled in the form of prefix 2.2.6-trimethyl-4-ethyl

(5) The complete name

"2,2,6- trimethyl-4-ethyl heptane"

A L K A N E S

Occurence of alkanes:

Natural gas and petroleum are mixtures of many hydrocarbons most of which belong to the alkane series . The different types of hydrocarbons can be separated only by fractional distillation into components which have similar boiling range e.g. the portion that boils between 50and 200 C is gasoline which is the fuel used for cars.
The part that boils between 200-300 C is keresene which is used in daily life.

Kerosene or gasoline are mixtures of hydrocarbons which have very close boiling points.

Some general methods of prepation:

(a) By the grignard reaction : About 1900 Grignard ,French , observed that a solution of methyl iodide in absolute ether (ether free from water) , reacts with metallic Mg and forms an eth er soluble compound , methylmagnesium iodide CH_3MgI . It was also found that other halogen derivatives behaved similarly

C_2H_5MgBr ethylmagnesium bromide

C_2H_5MgI ethylmagnesium iodide

or in general R MgX where R represents any hydrocarbon group

X " Halogen

(Cl, Br, I, rarely F)

Grignard reagent: A compound of th e type RMg X in absolute or dry ether is known as "Grignard reagent"

When Grignard reagent reacts with water it gives:

$$CH_3MgI + HOH \text{ ---------- } CH_4 + Mg\begin{smallmatrix} I \\ OH \end{smallmatrix}$$

or generally :

$$RMgX + HOH \text{ ----------- } RH + Mg\begin{smallmatrix} OH \\ X \end{smallmatrix}$$

If grignard reagent reacted with another molecule of alkyl halide or RX we get

$$RMgX + R'X \text{ --------- } R\text{–}R' + MgI_2$$

e.g.

$$CH_3MgI + CH_3\text{-}CH_2\text{-}I \text{ --------- } CH_3\text{-}CH_2\text{-}CH_3 + MgI_2$$

II Another method for the preparation of alkanes : Reduction of the double bond in unsaturated hydrocarbons

$$CH_2{=}CH_2 + H_2 \xrightarrow[\text{(catalyst)}]{Pt} CH_3\text{-}CH_3$$

General properties of alkanes:

1- The lowest member of the alkane series , containing four or less carbon atoms are gases. from C_1 .. C_4 ...... gases at room temp.

C_5-C_{17} ..... Liquids " "

C_{18}- upwards ..... solids as the carbon atoms increase the densities of the solids increase.

2- The boiling points of the straight -chained hydrocarbons increase with increase in the number of carbon atoms

3- The isomers of the straight -chained hydrocarbons which are branched are lower boiling points than those of the isomeric normal hydrocarbons

e.g.	n-pentane b.p	36.2 C
	isopentane	28
	neopentane	9.5 C .

Chemical properties of alkanes:

The alkanes are less than are most classes of organic compounds and for this reason, have been called paraffins(little affinity) ordinarily, they react with only powerful reagents or under conditions of high temperature and high pressure.

Inactivity with aqueous reagents:- Methane and the other members of the alkane series do not react with water solutions of acids, alkalies , $KMnO_4$ or other oxidizing agents and the usual laboratory reagents. This lack of activity is associated apparently with their non-polar character. High temperatures, strongly electro-
philic
phylic (electron seeking)reagents, or both are usually required in order to bring about any change in the structure of the alkane molecule.

Complete Oxidation (combustion) The alkanes burn in air or oxygen with the formation of CO_2 and water .

Here all the C-H bonds are broken also the C-C bonds are broken and CO_2 is formed in addition to water

$$CH_4 + 2O_2 \text{ -------- } CO_2 + H_2O + \text{heat}$$

$$2C_nH_{2n+2} + (3n+1)\ O_2 \text{ ------ } 2nCO_2 + (2n+2)\ H_2O + \text{Heat}$$

The heat generated is very large , that is why methane , butane , and other petroleum products are used for heating puposes and other similar purposes where high energy is required.

An insufficient supply of oxygen leads to the production of soot , formaldehyde (HCHO) , and other products.

e.g.

$$C_2H_6 + O_2 \text{ -------- } CO_2 + H_2O + 241 \text{ Kilocalori per mole}$$

or it is written as 241Kcal. /mole

Note : The quantity of heat liberated from the burning of differamt isomeric alkanes differ slightly.

Halogenation: (or substitution of a hydrogen by a halogen)

The replacenment of one or more hydrogen atoms of an alkane by a halogen occurs very slowly in the dark ,but more rapidly in sunlight , or by artificial ultraviolet light. (u.v.,)

Reaction of methane with a halogen leads to all four possible products:

$$CH_4 + Cl_2 \xrightarrow{u.v.} HCl + CH_3Cl + CH_2Cl_2 + CHCl_3 + CCl_4$$

Primary , Secondary and Tertiary Hydrogens:

primary or 1° : when the H-atom is attached to a carbon atom to which only one other carbon is attached e.g. in the CH_4 here the hydrogen atoms are 1°

also in CH_3-CH_3 here also the H are 1°

Secondary H-atom or 2° H-atom when the H is attached to a 2° carbon atom

e.g. $CH_3-CH_2-CH_3$ here the carbon atom present in the center is 2° because it is attaced to two other carbon atoms. And the H attached to this carbon is called 2° H-atom.

In the same way a 3° H-atom is found in isopropane C ... isobutane

here the the C-H are 3°

because the carbon here is attached to three C atoms

$$CH_3-\underset{\displaystyle CH_3}{CH}-CH_3$$

The activity of 1° H-atom differ from the 2° and 3°

2° H-atoms are replaced more rapidly than 1° also 3° is replaced more rapidly than 2°

Mechanism of Halogenation of methane:

1- Initiation stage: Consists of the dissociation of mole cular chlorine into Cl-atoms. Much energy is required to rapture the covalent bond and this energy is supplied when the Chlorine molecules absorbs a quantum of light energy

$$Cl{:}Cl + \text{radient energy} \longrightarrow 2\,Cl^{\bullet} \quad \text{(free radical)}$$

2- Propagation stage, A Cl-atom which requires an electron to fill its outer shell collides with methane where it takes up a H-atom and displaces a methyl radical:

$$H-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-H + Cl^{\bullet} \xrightarrow{hv} \underset{\text{free radical}}{CH_3^{\bullet}} + H-Cl$$

The methyl radical, in turn upon collision with a molecule of Chlorine displaces a $Cl^{\bullet}$ atom with the formation of methyl chloride. These steps can be repeated until some reactions removes one or both of the active free radicals

$$H_3C^{\bullet} + Cl{:}Cl \xrightarrow{hv} CH_3Cl + Cl^{\bullet}$$

(The $Cl^{\bullet}$ and the $CH_3^{\bullet}$ are called free radicals because of their odd electron)

3-Possible termination reactions:

$$2\,Cl^{\bullet} \longrightarrow Cl{:}Cl + \text{enrgy}$$

$$2CH_3^{\bullet} \longrightarrow C_2H_6 + \text{energy}$$

$$CH_3^{\bullet} + Cl^{\bullet} \longrightarrow CH_3Cl + \text{energy}$$

A chain of reactions is terminated by combination of the free radicals with themselves, usually on the walls of the reaction vessel so that the energy liberated in the formation of the bond may be dissipated, or by the exhaustion of the reacting materials (sometimes the reaction cannot be stopped until we get CCl_4

Chlorination of a compound containing a 3° carbon atom:

e.g. isobutane

$$CH_3-\overset{\displaystyle CH_3}{CH}-CH_3 + Cl{:}Cl \xrightarrow{hv} CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle Cl}{C}}-CH_3 + CH_3-\overset{\displaystyle CH_3}{C}-CH_2-Cl$$

tert-butyl chloride 5 9-parts; isobutyl Chloride 9-parts

in this reaction we have 9 . 1° hydrogens i.e. nine chances for the reaction
we la also have one . 3° " i.e. one chanc4 for the reaction

we can see from this that the 3° H-atom reacts faster than the 1° with the ha logen

Bromination of alkanes proceeds in somewhat the same manner as chlorianation although less vigourously .Iodine does not react while Fluorine reacts very vigourouly leading to the explosion of the reacting vessel.

Florine may be made to react by dilutineg it with nitrogen and by the use of special apparatus which removes the heat of the reaction very quikly

Pyrolysis of alkanes: (craking) When the paraffin hydrocarbons are paaed through tube tubes heated to 5oo-8oo °C , a thermal decomposition (pyrolysis) or craking occurs whereby the larger hydrocarbon molecules are broken into smaller molecules.

In an alkane there are two types of bonds: (1) the C-C bond and the C-H

Here the C-C bond is the more easily broken .

The amount of energy required to dissociate a gaseous molecule A:B into the fragments $A^\bullet$ & $B^\bullet$ per mole is called the bond energy . In ethane molecule
the C-C bond energy is 77.7 Kcal/mole
whereas the C-H " 98.2 "

Hence , the pyrolysis reaction, yielding ethylene and H_2 , may be expexted to proceed by a free radical mechanism as indicated below:

(1) $CH_3{:}CH_3 + \text{heat} \longrightarrow 2\ CH_3^\bullet$

(2) $CH_3{:}CH_3 + CH_3^\bullet \longrightarrow CH_4 + CH_3-CH_2^\bullet$

(3) $C_2H_5^\bullet \longrightarrow CH_2=CH_2 + H^\bullet$

($4) $CH_3{:}CH_3 + H^\bullet \longrightarrow C_2H_5^\bullet + H_2$

step (3) &(4) repeat themslves many times

Overall reaction :

$$CH_3-CH_3 \xrightarrow{\text{pyrolysis}} CH_2=CH_2 + H_2 + CH_4$$

we get mainly ethylene, some CH_4 and H_2

Pyrolysis of propane we get (1) propylene + H_2

at 5oo°C (2) ethylene + CH_4

Pyrolysis of octane

octane which is a larger molecule found in petroleum upon pyrolysis it gives:

upon pyrolysis

(1) $C_8H_{16} + H_2$

(2) $C_4H_{10} + C_4H_8$

(3) $C_4H_8 + C_3H_6 + CH_4$

In petroleum refining the cracking process is very important to for it makes possible the production of gazoline from hydrocarbons of less4r commercial val… which have higher molecular wt.

Isomerization : Conversion of one isomer into the other , it is of importance in the manufa cture of high quality gazoline which is used as a fuel fo cars etc..

e.g. Conversion of n-butane into isobutane

$$\underset{\text{n-butane}}{CH_3-CH_2)-CH_2-CH_3} \quad 66\xrightarrow[\text{Trace of alkene}]{AlBr_3,\ HBr} \quad \text{Isobutane}$$

Dehydogenation : Alkanes may be converted into alkenes when passed over suitable catalysts at temp . of 5oo-7oo°C (the catalyst may be either

Cr,Mo ,V,Titanium ...)

$$CH_3-CH_3 \longrightarrow CH_2{=}CH_2 + H_2$$

$$CH_3-CH_2-CH_3 \longrightarrow \underset{\text{propylene}}{CH_3-CH{=}CH_2} + H_2$$

§§§§§§§§§..§§§§§§§§...§§§§§§§§§§§§...§§§§§§§§§§§§

Cycloalkanes : Here the alkanes form rings of the general formula C_nH_{2n} which isomeric with the alkenes which have the same general formula e.g.

	b.p.
cyclopropane	-34
cyclobutane	12
cyclopentane	49.2 °C
cyclohexane	8o.8 etc..

§ UNSATURATEN HYDROCARBONS §

Alkenes or olefins

The alkenes are characterized by the presense of a double bond between two carbon atoms whih is indicated in the nomenclature of these hydrocarbons by the endinf ene

The general formula implies that the first member of the family might be CH_2: methene, but here the carbon atom has two unpaired electrons i.e. we have a free radical which cannot exist as a stable entity because of its valence structure Consequently the family begins with ethylene $CH_2{=}CH_2$

MNomenclature of alkenes :

1- common names : The first four have common names ethyle ne , propylene, butylene amylene

2-There is also the derived name e.g. for propylene we can a say methylethylene

3- IUU.C. System (most important method of nomenclature)

In applying the I.U.C. system to a hydrocarbon that has a doubde bond in a side chain , the name is based upon the longest chain that contanis the double bond

-Priority in numbering of the carbon atoms is given to the side nearest to the double bond

$$CH_3{-}CH_2{-}\underset{\overset{\parallel}{CH_2}}{C}{-}CH{-}CH_3$$

2-Ethyl-3-methyl-1-butene Here the i 1-butene means that the double bond exist at carbon atom number 1

$CH_2{=}CH{-}CH_2{-}CH_3$ 1-Butene

$CH_3{-}CH{=}CH{-}CH_3$ 2-Butene

I.U.C.	Common name
Ethene	ethylene
propene	propylene
butene	butylene
pentene	
hexene	
heptene	
octene	
nonene	
decene	
methylpropene	isobutylene
1-Butene	alpha-butylene
2-butene	beta - bytylene

in common names, the position of the double bond is indicated by alpha , beta, ... instead of 1,2,3,

Electronic structure of the alkenes:

The two bonds are not identical in the double bond. One of then is an ordinary bond but the second one whi ch asoconsist of a pair of electrons are most likely to be found above and below the plane defined by the two carbon and fouer hydrogen nuclei (actually in two sausage-shaped regions lying above and below the two carbon nuclei.

The latter pai of electrons can be attacked more easily than the ordinary by electrophylic (electron-seeking reagnets)

In a molecule containing a double bond, the atoms of the molecule are somwhat hold in fixed positions so that rotation of the double bond, though not entirely prohibited, but definitely restricted i.e. it is not so easy to rotate.

Summery ;

(1-) The double bonds restricts rotatøon and make possible the exiztence of cis and trans isomers

(2) In chemical reactions, the alkenes are electron donors (lewis Bases)

Cis-Trans or geometrical isomers :- Because of the restriuted rotation at the double bondin an alkene molecule Certain alkenes may exist as two distinet types of molecules called cis-trans or geometrical isomers

e.g. 2-butene is known in two isomeric modifications

CH_3- C-H
"
CH_3- C-H

Cis-2-Butene

CH_3-C-H
"
H - C -CH_3

Trans-2-Butene (I.U.C. nomenclature)

In alkanes the rotation around single bonds is easy and very small amount of energy is required. while here when we have a double bond, the amounts of energy required to convert one form to another are ordianarily much higher than that available to the molecules at room temp. (and in the absence of irradiation) . Therefore these isomers were isolated

Cis-2-pentene trans-2- pentene cis -1,2-Dichloro-1-bromoethane
trans "" "" "" ""

Some general methods of prepatation :

(1) Cracking of alkanes

(2) Dehydration (removal of H_2O) from alsohols by the action of conc, H_2SO_4

$$C_2H_5OH \xrightarrow[-H_2O]{conc.\ H_2SO_4} CH_2=CH_2$$

ethyl alcohol ethylene or ethene

Some general physical properties :

Ethylene is a colourless gas of a sweetish, slightly soluble in water. Priopylenens and the three butylenes are gases also under ordinary conditions

C_5 to C_{17} are liquids

C_{18} upwards are solids

Chemical pro perties :

Since these compounds contain a double bond, they are very reactive compared to the alkanes and try to saturate the carbon atoms which have the double bonds.

1) Oxidation :

(a) Combustion: Alkenes burn in air with a luminous flame. The unsaturation of the molecule results in a greater percentage of carbon in the alkene than in the alkanes of the same number of carbon atoms , and het particles in the flame produce increasedd luminosity. That is why the flame appears luminous whereas in the burning of methane or butane we notice a non-luminous flame (e.g. flame of a bunsen burner)

(b) Baeyer test for unsa'turation: Any unsaturated molecule will reduce the colour of a dil. solution of $KMnO_4$ with loss of the purple colour and the appearence of a brown ppt of MnO_2

$$3\ CH_2{=}CH_2 + \underset{\text{purple solution}}{2\ KMnO_4} + 4\ H_2O \xrightarrow{\text{COLD}} \underset{\text{ethylene glycol}}{3\ \underset{OH}{CH_2}-\underset{OH}{CH_2}} + \underset{\text{browm ppt.}}{2\ MnO_2} + 2KOH$$

This is the first step in oxidation ; if we use hot conc. $KMnO_4$ solution , complete oxidation to CO_2 and MnO_2 takes place.

2) Addition of H_2: In the presence of pt or Ni catalyst, the olefins add hydrogen and form paraffins (alkanes) with the evolution of heat

$$CH2{=}CH2 \xrightarrow{H_2\ /\ \text{Ni catalyst}} CH_3-CH_3 \quad =+\ 31.6\ \text{Kcal.}$$

3) Addition of Halogens :

$$CH_2{=}CH_2 + \underset{\text{yellow solution}}{Br{:}Br} \longrightarrow \underset{\text{ethylene bromide}}{\underset{Br}{CH_2}-\overset{Br}{CH_2}}$$

colourless solution

(F_2, Cl_2 add to the alkenes more rapidly than bromine . I_2 gives a reversible reaction

4) Addition of HBr (here the Br^- ion addds to the carbon atom that has the the lowest number of hydrogens)

$$CH_2{=}CH_2 + HBr \longrightarrow \underset{\text{ethyl bromide}}{CH_3-CH_2\,Br}$$

5) Addition of H_2SO_4

$$CH_2{=}CH_2 + H_2SO_4 \longrightarrow CH_3-CH_2-OSO_3H$$

here the OSO_3H adds to the C atom with the lowest numbe of hydroge[illegible]

This is the basis for the removal of unsaturated hydrocarbons from [illegible]

6) Polymerization of ethylene

ethylene and other compounds that contain a double bond has the ability to react with itself or with other [illegible] long chained compounds called polymers (see book , chapter of org. chemistry)

Note : There are compounds with more than one double bonds e.g called dienes when we have two double bonds , trienes . when we have three double bonds

PETROLEUM & PETROCHEMICALS

Petrol was known for a long time . In ancient history it was used in Iraq as a building material (Babylnians or Assyrians used bitumen which is one of the derivatives of petrol for building) . Also some of the Indians of North America used to collect and sell the oil or petrol ,as it is sometimes called, from the wells of Pennyselvania.

No one however seemed to have realized the importance of thiis oil until it was found that paraffin oil could be made from it . Then when the internal - combustion machines were invented (e.g. cars , aeroplanes ..) , petroleum became of world wide importance.

Petrol and its products is not only important as a sourseeof fuel and lubricants but a;so as a raw material i.e. from it we can get prepare many derivatives such as plastics , synthetic rubber, drugs , etc...

Origin of petroleum: Natural gas and petroleum have been formed over the course of the ages : by the decomposition of organic material of marine origin (sea plants and animals) and these decopposition prosucts has accumulated in porous rock formations on earth pockets capped by rock. When a well is drilled through the cap, natural gas escapes and , for a time , oil may be forced to the surface by pressure . After the pressure has subsided , the oil must be pumped out of the well.

It should be noted that the constituents of one oil well may be different from that of another but all contain saturated hydrocarbons and other products.

Constituents of petroleum:

1- Natural gas: The gas at the well head contains not only methane , but also ethane ,propane, butane, isobutane and vapours of low boiling-point liquids :pentanes, and hexanes .The hydrocarbons of three or more carbon atoms are easily liquified by cooling and compression and are thus removed from the methane n and ethane. Fractional distillation of the liquid so seperated, yields commercial quantities of propane and the two butanes that are used both as a fuel and as raw materials to prep. other products .

In addition to the hydrocarbons , natural gas may contain H_2S (compare coal gas which also contains this gas) also natural gas contains Helium, N_2 .

H_2S must be removed because gases containing it (sour gases) have a bad odour also they corrode the apparatus used to transport the gases . When a gas is burned and it contains H_2S, ,SO_2 will be formed from the reaction and the room is filled t with this poisonous gas .

For these reasons H_2S has to be remeved from natural gas .

He which is often present to the extent of 1 % or more, is removed by extracting plants from which the He supply may be obtained.

Natural gas as supplied to houses and used contains :

about	82-87 %	methane
	6-10 %	ethane
	1-4% %	propane
	1 %	butane
	1-8 %	Nitrogen (these quantities might sometimes differ a little bit)

II MOTOR FUELS: The production of motor fuels from petroleum consist of several steps :

1- fractionation: The first operation in the refining of petroleum is a fractionl distillation by which the crude oil is separated into a series of "fractions "

fractions or "cuts" having different ranges of boiling point . In the distillation process each portion of the distillate is collected between those temperatures that have been found to give best products best suited to various commercial purposes,.

The fraction that distils between the initial boiling point	- 7o=°C	Petroleum ether
" " " " " " "	58-2oo	is gasoline medium b.p.
" " " " " " "	2oo-3oo °C	" Kerosene
	above 3oo	" distillate " or furnace oil
		gas oil
		light lubricating oil
		medium lubricating oil
		heavy lubricating oil

at the end oft the distillation , a residue of asphalt or coke remains in the still

Crude petroleum is first passed through petroleum refinaries where it is heated above 4oo°C most of it is changed to vapour then this is passed through the fractionating column where the vapours go up from the lower part of the column.

Here the heaviest vapours condense first (e.g. a fraction which boils at 3oo°C will, as the vapours cool a littles bit, condense at the lower part of the column A black residue which is asphalt and tar and sometimes coke remains is the still (still: distilling apparatus) . The lightet portions of the vapours are passed to other fractionating the columns where they condense at the temp . listed above This method is v called "fractional distillation".

I When the heavy lubricating oils are chilled , paraffin wax and vaseline is deposited. After the removal of vaseline, and paraffin wax , the lubricating oils are washed with selective solvents for removal of the sludge forming materials

II Desulphurization : Petroleum distillates often contain H_2S and other Sulphur containing materials such as R-SH (mercaptans) which have a bad odour and cause corrosion of metallic containers(remember that H_2S is a reducing agent)

The H_2S and some of the sulphur derivativ es are remeved by washing with NaOH solution

The remaining sulphur derivatives are convert ed into the odorless , non-corrosive dialkyl disulphides by treatment with Na_2PbO_2 (sod. plumbite) in the presence of S

$$R\text{-}SH + NaOH \text{-------} RSNa + H_2O$$

$$R\text{-}SH + Na_2PbO_2 + O_2 \text{-------} R\text{-}S\text{-}S\text{-}R + PbS + 2\ NaOH$$

The Na_2PbO_2 is called Doctor's solution and this process is called sweetening

III Cracking and reforming: The gazoline obtained by distillation of petroleum, called "straight -run gazoline" is a poor motor fuel and also is insufficient in amount to meet the demand. Increased quantities of gazo line are obtained by the cracking process (see reactions of alkanes) by which the larger hydrocarbons contained in the "gas oil" are broken into compounds having 5-1o carbon atoms per molecule.

Reforming : After the cracking the product is converted from continous-chain hydrocarbons to branching structures which have higher value as motor fuels

method: Pass gazoline under pressure rap idly over a catalyst contained in a heated steel pipes . The time of contact between the gazoline and the catalyst is 15 seconds

or stright -chained hydrocarbons $\xrightarrow[\text{15 seconds}]{\text{Catalyst}}$ branched chains

Octane rating:

Tests on pure individual hydrocarbons in a motor desighed especially for the purpose reveal :

That continuous-chain hydrocarbons of branching structure are relatively non-knoking .

an evaluating system was made : since n-heptane knocks badly it is rated as zero while iso-octane has a high "antiknock" characteristic and it is rated as 1oo

If we have a sample of gazoline and we want to know its qualityi.e. its octane rating, we compare its antiknocking qualities in the test engine with that of a mixture of the two reference hydrocarbons (n-heptane and iso-octane)

If the gagoline has the same anti-knocking value as a mixture of 75% isooctane and 25% n-heptane, that sample of gazoline has an octane rating of 75

Other hydrocarbons has been found recently that are worse that n-heptane, whereas some have been obtained which are better than n-octane. e.g. n-nonane has an octane value of -45 while 2,2,3-trimethylbutane , an octane rating of +116

The addition of tetraethyl lead to gasoline greatly decreases knocking and permits the use of motors with higher compression ratios than would otherwise be possible The combustion of gazoline containing tetraethyl lead produce a deposit of oxide which may roughen the cylinderwalls in the engine. Hence ethylene bromide ($C_2H_4Br_2$)

and ethylene chloride along with a red dye are incorporated into the ethyl fluid gazoline in order to remove lead in the exhaust gases as lead halide which is volat volatile at the temp. of the combustion of the fuel.

Note : Synthetic fuels: In the time of war , various countries particularly Germany have been forced to develop methods of preparation of synthetic fuels to supplement supplies of petroleum products . The raw materials of the synthesis of fuels have usually been coal , hydrogen and carbon monoxide.

Petroleum products other than fuels:

1- Cyclopropane : used as anesthetic.
2- naphthas : volatile petroleum fractions that are widely used in the dry-cl cleaning and varnish industries

3-Liquid Parrafin (liquid petrolatum) or Mi neral oil : made from the fractions boiling between 330-390°C
It is used in cosmetic creams, Hairdressings, it is also used as a laxative

4-Lubricating greases . used to lubricate the machines
5-Petrolatum (vaseline)
6-Paraffin wax for making candles , coating paper ...
7- Other derivatives ...

PETROCHEMICALS. Petrochemical industry is becoming more important every day because many products can be made starting with petroeum as a raw material e.g detergents , plastics , synthetic rubbers . drugs . etc..

Although petroleum , accumulated in the earth throughout the ages , is of animal origin, it is usually sclassified as a mineral resource and paradoxical as it might seem , we now obtain most of our organic chemicals from the mineral kingdom.

* In the new type of gazoline which contain molecudes which has an high octane rating , there is no more any need to add lead tetraethyl.

Alcohols:

Are derivatibes of hydrocarbons with one or more hydrogens replaced by OH groups. Thus we can get monohydroxy alcohols when one H is replaced by OH Also we can get dihydroxy- and polyhydroxy- alcohols

We are concerned here with monohydroxy alcohols.

General methods of nomenclature :

1- I.U.C. As in the alkanes but here the ane is replaced by ol. e.g propanol

C_3H_7OH

here the position of the CH group should be given a number e.g.

```
      H                          OH
CH3-C-CH2OH               CH3-C-CH3
      |                          |
     CH3                        CH3
2-methyl-1-propanol       2-methyl-2-propanol
```

we shall have ' methanol, ethanol , propanol ...) In propanol , there are two isomers 1-propanol and 2-propanol

2- There are other type of naming we cqn say methyl alcohol
ethyl alcohol
n-propyl "
isopropyl "
n-butyl "
isobutyl "
sec-butyl "
tert-Butyl " .... these are common names
amyl alcohol
isoamyl "

when the chain is longer we use the I.U".C system

Preparation of alcohols:

1- Hydrolysis of alkyl halide:

$CH_3\text{-}CH_2\text{-}I + KOH \text{---------} CH_3\text{-}CH_2\text{-}OH + KI$

$CH_3\text{-}I + KOH \text{---------} CH_3I + KI$

2- Hydration of alkenes by the use of H_2SO_4

$$CH_2{=}CH_2 + H_2SO_4 \text{--------} \underset{H}{CH_2}\text{-}CH_2\text{-}OSO_3H \xrightarrow{HCH} CH_3\text{-}CH_2OH$$

ethyl alcohol
or ethanol

The unsaturated gases from the cracking stills at oil refinaries provide large quantities of materials suited to the production of the alcohols by hydration Hydration (i.e. addition of a molecule of water to the double bond) can be accomplished by the use of acids (ordinarily H_2SO_4) .

An alkene by absorption in H_2SO_4 , forms an alkyl hydrogen sulphate which , in turn yields alcohol by hydrolysis.

3- Alcohols by fermentation: Ethanol C_2H_5OH may be obtained by fermentation of

Alcohols continued

of glucose or other sugars

$$C_6H_{12}O_6\,(aq) \xrightarrow{\text{zymase enzyme}} 2\ C_2H_5OH\,(aq) + 2\ CO_2\,(g)$$

glucose or fructose

If we have starch first the starch has to be hydrolysed by the use of another enzyme called diastase:

$$(C_6H_{10}O_5)_n + n\ H_2O \xrightarrow{\text{Diastase}} nC_{12}H_{22}O_{11} \xrightarrow{\text{maltase}} 2n\ C_6H_{12}O_6$$

gluoo se

$$\text{g;ucose} \xrightarrow{\text{Zymase}} \underset{\text{alcohol}}{C_2H_5OH} + CO_2$$ (same equation as above)

The alcohol may be separated from the water by fractional distillation where we get 95.6 % alcohol (ethyl alcohol is called simply alcohol)

Commercial ethyl alcohol has a concentration of about 95%

Absolute alcohol: Can be obtained by distilling the alcohol with lime (CaO)

Physical properties of alcohols:

Alcohols exhibit H-bonding that is why they have higher boiling points than other derivatives e.g. methanol has the lowest molecular wt of all the derivatives of methane but has the highe st boiling point . This is due to molecular association or we can say it is due to H-bonding existing between the molecules.

That is also the reason why methanol and ethanol are completely miscible with water in all proportions.

The soblubility of alcohols decreases so rapidly with increasing number of carbon atoms e.g. n-hexyl alcohol $C_6H_{13}OH$ dissolves in water to the extent of only 1% at 20C . Hexyl alcohol and those higher alcohols in the series consist mairly of a relatively small portion of the molecule. The alcohols illustrate the re the rule that <u>like dissolve like</u> . Those of low mumbers are solub soluble in water but the higher members are soluble in organic solvents only

Chemical properties of alcohols:

As an example of alcohols we take methyl alcohol or methanol

1-<u>Reactions of alcohols as acids</u> : metallic Na added in small pieces to ethanol reacts with the genile evolution of hydrogen

$$2CH_3-CH_2OH + Na \longrightarrow \underset{\text{sodium methoxide}}{C_2H_5ONa} + H_2$$

The fact that one H-atom in the alcohol molecule can be replaced by Na is an important point in the proof of the molecular structure of an alcohol. The paraffin hydrocarbons have no reaction with Na ; hence the H attached to the Oxygen atom is the only one replaced.

The alcohols are extremely weak acids and their salts are readily hydrolysed by water:

$$C_2H_5O^-Na^+ + HOH \rightleftharpoons C_2H_5OH + NaOH$$

<u>Ca also reacts with methyl alcohol but the reaction is slower that Na</u>

2- <u>Reaction of alcohols as bases</u>: The alcohols may act as electron donors (bases) in reactions with acids or with PCl_3

a-reaction with acids : Alcohols react with organic acids such as acetic acid (CH_3COOH) also with inorganic acids such as HCl

$$C_2H_5CH \quad + \quad HBr \text{ -------- } C_2H_5Br \quad + \quad H_2O$$

Ethyl bromide

$$\underset{\text{alcohol}}{C_2H_5CH} \quad + \quad \underset{\text{acid}}{CH_3COOH} \text{ ------- } \cancel{C_2H_5} \quad \underset{\text{ethyl acetate ester}}{CH_3COOC_2H_5} \quad + \quad \underset{\text{water}}{H_2O}$$

In organic chemistry we have the word <u>ester</u> whenever an alcohol reacts with an organic acid the product is called an ester . Here the reaction is reversible

We can easily hydrolyse the ester formed by the addition of an acid

3- Reaction with phosphorus halides

$$PX_3 \quad + \quad ROH \text{ ------ } RX \quad + \quad H_3PO_3$$

e.g. $PCl_3 \quad + {}_3C_2H_5OH \text{ -------- } {}_3C_2H_5\,Cl \quad \neq + \quad H_3PO_3$

POLYMERIZATION

More than half the chemical industries of the united states is based , at least , in part , upom polymerization processes. A large amount of products ranging from baby bottles to automobile bodies or motor boats are being manufactured from plastic materials which are one type of polymers

Polymerization: Consists of the chemical combination of a large number of molecules of a certain type called monomers, to form a giant molecule called a polymer.

Depolymerization: Is the reverse of polymerization, it is the dissociation of a giant molecule into n units of monomer by a chemical or thermal process.

Polymeri zation reactions accur in living tissue such as the formation or the building up of cellulose and starch from simple small sugar molecules in plant cells . Also the process of digestion in the body is a process of depolymerization stach is broken up into sugars ; Proteins are another type of polymers which are found in plants and animals . They are synthesized from amino acids which are the building units of the proteins . Some proteins are also depolymerized in the stomach into the amino acids and the body makes use of the amino acids liberated to be used as building units in the body (or some amino acids are oxidized further to urea and other products where the body gets use of the energy liberated during these reactions....)

Polymers may be [illegible]

1- Linear: M-M-M-M-M-M...

where one type of molecule reacts with itself to form long chains . These giant molecules that are formed are called Macromolécules (macro : big)

e.g. of such linear molecules: Polyethylene ; starch

(in polyethylebe the monomer here is ethylene
in starch the monomer here is glucose)

2-Linear Co-polymer : M-A-M-A-M-A- .....

Here we have two small molecules which react together forming long chins e.g nylon

3- Minor cross-linked polymer :

```
M-M-M-M-M-M-M-M-M-  ....
  X         X
M-M-M-M-M-M-M-M-M-M-  .....
```

e.g. of such polymer is vulcanized rubber where X represents -S- atoms

4- Polymer with massive cross- linking e.g. urea-formaldehyde resin which is a type of plastic which does not break easily

It should be pointed out that these are ideal structures . (1) &(2) may well have branches on the chains and the chains are certainly not [illegible] straight

There appear to be at least three principal arrangements of linear polymers
(1) An extended rod-like arrangements ;e.g. polyethylene

In polyethylene, here the polymer is in a rod-like molecules. The rod-like molecules in polyethylene pack together in an ordered manner(like uncooked spagetti in a box) ; and the resulting crystalline polymer resists distortion when heated to temperatures below the m.p. (about 140 C) and also resists the solvent action of common solvents.

(2) A randomly coiled arrangement (like a tangled string) e.g. bulyl rubber

The polymer assumes a randomly coiled arrangement , one polymer chain becoming intertwined (intermixed) with other chains .

Thus the attractive forces between the chains are small , and the polymer has a a fluid deformable character . The [illegible] molecules can uncoil when the polymer is pulled and they return to the randomly coiled arrangement when the stress is remeved . This gives the polymer a rubber- like characteristic

SOME EXAMPLES OF POLYMERS:

I- Synthetic fibers:

(a) Nylon: the name nylon has been applied to the plastic polyamide which may be made from dibasic acids (acids having two COOH groups) and diamines (molecules having two NH_2 groups

Other dibasic acids and diamines yield polyamides in a similar manner and the nam nylon refers to the general group of such products rather than to an individual substance (i.e. there are many types of nylon molecules but all consist of one general structure)

It is also possible to prepare such polyamides in which different dibasic acid and various diamines are interspersed in the long "polyamide" chains

Thus 'nylons' of widely varying properties can be produced.

The long chained molecules have a random arrangement in an undrawn nylon-fiber but the molecules become oriented into approximately parallel positions by drawing the fiber to several times its original length.

Mechanism of the reaction taking place: In the polymerization reaction a H -atom in the NH_2 group of the amine combines with the OH of the COOH group of the dibasic acid (containing two COOH groups) to form water and the two monomers arelinked together.

then the process is repeated and we get long polymer chains .Nylon is used to make great many things from sheerest hosiery to large gears of machinary ,

General reactions :

HOOC-R-COOH + $H_2N-R'-NH_2$ ------ ....CO-NH-R'- NH-CO-R-CO-NH-R'-...

polyamide

or simply

-CO-NH- -NH-CO- -CO-NH - ....

---

e.g. Nylon-66

$H_2N-(CH_2)_6-NH_2$ + $HO-CO-(CH_2)_4-COOH$ + $H_2N-(CH_2)_6-NH_2$ ------ Polyamide + H_2O

II Terylene : (Dacron) It is a polyester (monomers ~~are terephthalic acid and~~ ethylene glycol) It is a new synthetic fiber.

In addition to wrinkle-resisting ~~property, and dimentional~~ stability, it is resistent to moths, mildew and abrasion

It is used mainly in clothes.

III -Plastics: this is another group of polymers.

There are two types of plastics

(1) Thermoplastic: which are affected by heat. On heating the y lose their rigid rigidity because there are no permanent bonds between the chains and so, on heating the long molecules will move about and the distance between individual chains will increase Hence the material becomes less rigid and soften readily with small increases of tempreture , as only small amounts of heat energy are required to overcome the weak attractive forces. On cooling the movement becomes less and the material becomes rigid again.

These materials are thermoplastic (softening and hardening are reversible)

(2) Thermosetting: This type of plastic is not affected by heat It is useful in many fields of industry. In this type there are multiple cross- linkages That is why they do not soften when heated or a large amount of energy is required to break these cross-linkages where the compound decomposes completely

```
... M-M-M-M-M-M-  .....
    ' ' ' ' ' '
    A A A A A A          Multiple cross- linking -   resists  defomation by heat
....M-M-M-M-M-M-....
```

Examples of plastics :

I -Polystyrene : Styrene undergoes linear polymerization yielding the thermoplastic polystyrene (affected by heat).

To decrease the themoplatic character another compound is added to it in very low concentration such as divinyl benzene ; this is added in small concentration with the styrene prior (before) to polymerization . This results in the formation of cross- linkages between the polystyrene units.

Uses: Polystyrene is widely used for rigid insulation and for molded articles . It is not affected by water that is why it is also used in bath materials

II - Perspex (It is methyl methacrylate polymer)

This type of plastic is hard and clear as glass . It is used for making optically clear plates and blocks, lenses and machinable castings and forms

It is a colourless transparent plastic which is sold under the trade name of ' Perspex '

The polymer is of linear character; Cross-linkages between the linear chains are almost non-existent ; hence the polymer belongs the to the thermoplastic group and softens when heated : it may thus be reshaped as desired.

Note: Some polymers are decomposed by heat , others by chemical reagents

Other types of polymers : Carbohydrates . Proteins, Silicones ...

Nomenclature of alkenes:

I.U. C.

1- Choose longest continuous chain which contain the double bond

2- Instead of using the word alk<u>ane</u> we use the word alk<u>ene</u> i.e. the name should end with <u>ene</u> e.g. Butene

3- The numbering of the chain is from the side which gives the double bonds the smaller mumber.

4- The double bond is named with the smaller number of the carbon atoms which form the the double bond.

5- Side chains are named as in the alkanes

e.g. $CH_2{=}\underset{|}{\overset{}{C}}{-}CH_2{-}CH_3$ with CH_3 on C-2: 2-methyl-1-butene

$CH_2{=}C{-}\overset{H\ H}{C}{-}CH_3$ with CH_3 on C-3: 3-methyl-1-butene

$CH_3{-}CH{=}C{-}CH_3$ with CH_3 on C-2: 2-methyl-2-butene

Polymerization of ethylene: Polymerization means a condensation reaction where a small molecules condense forming molecules of very large molecular wt.

e.g. ethylene polymerizes in acid medium p forming polyethylene :

$$CH_2{=}CH_2 \xrightarrow{H^+} CH_3{-}\overset{+}{C}H_2 \xrightarrow{CH_2=CH_2}$$

double bond is opened

$$CH_3{-}CH_2{-}CH_2{-}CH_2{-}\overset{+}{C}H_2 \xrightarrow{CH_2=CH_2} CH_3{-}CH_2{-}(CH_2{-}CH_2)_n{-}CH_2{-}\overset{+}{C}H_2$$

$$\xrightarrow{-H^+} CH_3{-}CH_2{-}(CH_2{-}CH_2)_n{-}CH{=}CH_2$$

polyethylene

This polymer is a very important plastic.

Calculations based upon such bombardment exp. as have been described showed that whereas atomic redu are usually of the order of 10^{-8} cm, the nuclu of the atoms are of the order of only 10^{-12} - 10^{-13} cm in radius. On the basis the volume of the atom is greater than that of the atom 10^{15} times.

From calculations based upon additional data from this same series of exp. Rutherford showed that the number of positive charges on the nucleus of an atom is at least in many cases somewhere near one - half the atomic weight of the element. The number representing the position of an element in the periodic system allowances having made for vacant spaces had previously been given the name atomic number. Sicne in many cases this number is about one half the atomic weight. Van de Brock made the suggestion in 1913 the atomic number of an element is equal to the number of positive charges on the nucleus of its atom. This hypothesis was soon confirmed by British Physicit Mosely.

Mosely showed that by bombarding elements with cathode rays, X - rays of characteristic wavelength are emitted. If the square roots of the frequescies of these waves are plotted against the "atomic.number" straight lines are obtained. The importance of this work was that it gave precision to the idea of atomic number which represents the order of the element in the Periodic table.

Mosely's Law established the conception that each element differs from the preceding one in the table by one nuclear charge & hence by one electron.

THE NUCLEUS

Positive rays -

In 1886 Goldstein found that in a tube having a perforated disc as cathode, if the pressure is not too low, colored rays may be seen to emerge from the side of the cathode opposite to the anode. It thus appears that these luminous rays move toward the cathode rather than in the opposite direction; and that they must therefore consist of positively rather than negatively charged particles. Moreover, studies of these particles by methods beyond our scope indicate that they are not all identical in nature; unlike the electrons which make up cathode rays these positive particles have charges and masses which vary that where as the cathode rays actually start from the cathode these positive rays originate in the space between the two electrodes. These facts support the now well established view that these positive rays consist of the positive residues or ions which are left when one or more of the electrons are knocked out of an atom or molecule of a gas in the tube by the stream of electron from the cathode. The study of such positive rays has been of profound importance in the development of the theory of the structure of the atom.

By the use of methods similar to those previously employed in the study of cathode ray particles, the ratio of charge to mass(e:m) was determined for the particles constituting the positive rays obtained with various residual gases in the discharge tube. The largest value of e:m for any positive ray particle was that found when hydrogen was used in the tube. This means, of course, that if we assume the charge (e) to have the same value in each case, the mass (m) of the positive ray particle obtained in the hydrogen tube is less than that for any other gas. Careful study has shown that such is indeed the case, and that this positive particle is one of the fundemental particles of matter. Its charge is equal in magnitude but opposite in sign to that of the electron, and its mass in 1836 times that of the electron or 1.0073 atomic weight units; this special type of particle has been given the name <u>proton</u> . The simplest of all atoms, the hydrogen atom, consists of a proton and an electron.

CONTINUED P.5

THE NEWTRON & NUCLEAR STRUCTURE

With the single exception of the isotope of hydrogen having a mass of 1, all the atoms have more units of mass than of positive charge in their nuclu It is therefore evident that the nuclu of these atoms must contain fundemental particles other than protones and in 1932 the English physicist.J. Chadwick discovered a third type of fundamental subatomic. He was able to show that the highly penetrating radi..on emitted by metallic berylium under bombardment by alpha particles consists of streams of particles having a mass of approximately 1 atomic weight unit (1.0087 a.w.n) and carrying no charge. This type of particle was given the name <u>neutron</u> . Although the internal structure of the atomic nucleus still remains a good deal of a mystery, the hypothesis that it is composed of protons and neutrons is now fairly generally accepted. It is accordingly assumed that an atom of approximate atomic weight (mass number) A and atomic number Z has a nucleus composed of Z protons and A-Z neutrons. According to this view, the nucleus of the isotope of lithuim of mass number 7 consists of 3 protons and 4 neutrons, while the isotope of hydrogen of mass number 1 has a nucleus consisting of 1 proton only, whereas the isotope of hydrogen having a mass number 2 has 1 proton and 1 neutron in the its nucleus. Thus we see that the nuclu of different isotopes of a given element differ onlyin the number of neutrons they contain; the nuclu of all isotopes of a given element have the same number of protons. (the same positive charge) and the atoms therefore have the same chemical properties.

POSITRON

American physicist.C.D.A.nderson discovered in 1932 that when cosmic rays a form of electromagnetic radiation apparently originating in interstellar space and having very great penetrating power, were allowed to pass through a sheet of lead, two types of particles were obtained. From the photographs of the tracks they produced in a cloud chamber under the influence of a strong magnetic field, it was shown that one of these types was the negative electron with which we are familiar. The other type was soon shown to have the same mass as the electron and the same amount of charge, the charge in this case is positive, however,and these particles were named <u>positrons</u>.

More recent research on cosmic rays suggests the existence of other nuclear particles and in particular a <u>meson</u>. This has a mass of about 100 times that of the electron and may be positively or negatively charged or uncharged.

Another nuclear particle is the <u>neutrino</u> which has no charge and praticaly no mass.

THE PERIODIC CLASSIFICATION

The first classification of elements depends upon the difference in the physical and chemical properties, classified as metals and non - metals. It was found that this classification is not sharp. Tries were made to classify elements in small groups depending on the similarity of chemical properties and its relation with the atomic weight.

THE TRIPLE CLASSIFICATION

Dobereiner (a German Scientist in 1829) found that elements that are chemically similar can be classified ingroups of three elements. When the atomic weight of one of the three elements. When the atomic weight of one of the three elements in any given group is equal to the arithematical mean of the weights of the two other elements. Such a group is Li (7) Na (23) K (39) .

so that $Na = \frac{Li + K}{2} = \frac{7 + 39}{2} = 23$

also Cl (35.5) Br (80) I (1265)

$$Br = \frac{Cl + I}{2} = \frac{35.5 + 126.5}{2} = 80$$

Continued p. 6.

2. The atom consists of (i) the nucleus at the centre (ii) and system of electrons in motion outside the nucleus. The mass of the atom is entirely concentrated in the nucleas, the volume of the atom is the volume which contains all the moving electrons.

THE ELECTRON

One of the most important steps in the development of the theory of atomic structure was the discovery of the electron and the determination of its charecteristics. The first experimental evidence that electrical charge is not a continuous fluid but made up of discrete particles was obtained.in 1833 by Micheal faraday in his studies of the conduction of an electric current by solutions of various substances. It was Stony 1874 and Helmholtz 1881 who first clearly understood their theoratical significance and stated the principle of the atomic nature of electricity in 1891 Stoney proposed the name <u>electron</u> for the elementry unit of electric charge.

Of all the studies involving the electron none has been more fruitful than those concerning the rays which emanate from the cathode (the negative electrod when an electric discharge is passed through a tube containing a gas at low pressure and hence are known as cathode rays. At ordinary pressures gases are extremely poor conductors of electricity and a very high voltage is therefore required to produce a discharge through a gas between two electrodes under these conditions. If

If the pressure of the gas in the tube is decreased however the conductivity rises rapidly. When the pressure has been reduced to the range of 0.01 to 0.001 mm Hg, the tube is filled with an invisible radiation, the presence of which is indicated by the fluorescence produced where it strikes the walls of the tube or a fluorescent screen placed in the tube.

The invisible rays have the following properties:

1. These rays proceed in straight lines from the cathode indicated by the fact that an opaque object in the tube causes a sharply defined shadow in the flüroscemt at the end of the tube apposite the cathode.

2. These rays have a mass. If a small paddle wheel is placed properly suspended in the path of a thin beam of the rays, then impact on the wheel causes it to rotate.

3. They are deflected by an electric field.

4. There are deflected by a magnetic field.

All of these properties as well as may others indicate that cathode rays are composed of negatively changed particles of appreciable mass. When it became apparent that these particles are identical with the elementary particles of electricity postulated by Stoney, they were called electrons. It is important to note that the nature of these cathode ray particles is independent both of the nature of the metal used for cathode and of the nature of the residual gas in the tube.

Metals have a tendency to emit electrons under the influence of dectromagnetic radiation, this phenomenon is known as the photoelectric effect. Only a few of the metals show this effect under the action of visible light but many more exhibit it when irradiated with electromagnetic rqdiation of shorter wave length and hence higher energy such ultraviolet light.

THE CHARGE MASS OF THE ELECTRON

The ratio of the charge on an electron to its mass was determined in 1897 by English J$J.Thomson by investigation of the behavior of the beams of electrons in electric and magnetic field. Such a calculation is possible because the extent tp which a beam of electrons is deflected under these conditions depends upon the charge on the electron, its mass and the velocity with which the electron is moving. The most recent work indicates that the ratio of the charge to mass of the electron is 1.759×10^8 coulom/gm - irrespective of the source of electrons.:

CONTINUED 3.

FRANK INY SCHOOL
& SHAMASH SECONDARY SCHOOL

Date: / /

Mr/Miss 's Class Record

Marks for Courses in Progress are bracketted.
Current Subjects for which no marks are available at present are marked (x).
Marks for subjects marked (na) are not available to this School.

Subjects								Average Number of periods per week in the different years.
School Forms		Frank Iny Intermediate School.			Shamash Secondary School.			
	Prep.	1st	2nd	3rd	4th	5th		
Equivalent to American Grades	7th	8th	9th	10th	11th	12th	P.G. Work	
Years Attended	19 19	19 19	19 19	19 19	19 19	19 19		
No. of years done in each form								
Remarks				Baccalaureate Exam.		Baccalaureate Exam.		
						1st. Semester.		
Arabic Language								6 periods
English Language								6 "
French Language								8 "
Bible								2 "
Arithmetic								3 "
Arithmetic with Algebra								3 "
Elementary Algebra								3 "
Plane Geometry								3 "
General Math. (Arith. Algebra & Plane Geometry)								7 "
Arithmetic with Trig.								3 "
Algebra with Trig.								6 "
Solid Geometry								3 "
Natural Science								4 "
Biology								2 "
Hygiene								2 "
Zoology & Botany								9 "
Physics with Chemistry								5 "
Physics								5 "
Chemistry								4 "
Civics								1 "
Status of Iraq								2 "
Ancient History								2 "
Islamic History								2 "
Modern European History								3 "
Geography								2 "
Social Sciences (Civics, History & Geography).								5 "
Arabic-English Translation with Islamic History.								3 "
Economics								2 "
English Language & Correspondence								10 "
Commercial Law								3 "
Business Methods								3 "
Business Methods & Commercial Law								3 "
Book-Keeping & Accountancy								6 "
Commercial Arithmetic								4 "
[illegible]yping								4 "
[illegible]ercial Geography								3 "
[illegible]ge mark in all subjects								
[illegible] students in class								
[illegible]of student in class								
[illegible]ng mark(Drawing is optional)								2 "
								8 "

FRANK INY SCHOOL &
[illegible] SECONDARY SCHOOL

Date: / / - P.3 -

Other Examinations passed bythe above candidate:

1. Iraq State Baccalaureate Examination for Primary Education,in June/ and September 19 , passing with distinction and/ranking 1st, 4th.etc. among 20, 28, etc. candidates from Frank Iny Primary School/or Menahem Daniel Primary School/or School in Baghdad. This examination is, in standard, equivalent roughly to the Common Entrance Examination of the English Schools or to grade 7 of the American Schools.

2. Certificat d'Etudes Primaires Examination, conducted in Baghdad by a special commission from the Lebanon, in May 19 , ranking 1st, 3rd, etc. among 20,28, candidates from Frank Iny School and 4th, 6th, etc. among candidates from all Schools in Baghdad.

3. Cambridge University Lower Certificate Examination in English for overseas students, in June/December 19 , ranking among candidates from Frank Iny School.

4. Brevet Elementaire Examination in French, Literary Section,/ or Scientific Section, conducted in Baghdad by a special Commission from the Lebanon, in May 19 , ranking among candidates from Frank Iny School and among candidates from all Schools in Baghdad.

5. Iraq State Baccalaureate Examination for Intermediate Education, in June/and September 19 ranking among candidates from Frank Iny School and among candidates from all Schools in Baghdad/or Iraq.

6. Iraq State Entrance Examination to the Fourth Secondary Form, Scientific Section, in Mathematics, Physics and Chemistry, in June/and September 19 , ranking among candidates from Frank Iny School and among candidates from all Schools in Baghdad/or Iraq. His or her marks in this examination were as follows:

   ....% in Mathematics.
   ....% in Physics & Chemistry.

7. London University General Certificate of Education Examination in the following subjects:

%Mark or Grade obtained	Subject	Level	Date
-	Classical Arabic (Arabic was originally sat at (A) level)	Advanced Ordinary	June/Nov./Jan 19
- (Oral)	French (French was originally sat at (A) level).	Advanced Ordinary	June/Nov.Jan.19
-	English Language	Advanced Ordinary	June/Nov.Jan.19
-	English Literature	Advanced Ordinary	June/Nov.Jan.19
-	Pure Mathematics	Advanced Ordinary	June/Nov.Jan.19
-	Applied Mathematics	Advanced Ordinary	June/Nov.Jan.19
-	Physics	Advanced Ordinary	June/Nov.Jan.19
-	Chemistry	Advanced Ordinary	June/Nov.Jan.19
-	Additional Mathematics	Ordinary	June/Nov.Jan.19
-	Further Mathematics	Advanced	June/Nov.Jan.19

FRANK INY SCHOOL
& SHAMASH SECONDARY SCHOOL

Date: / /

Note:1. Highest mark in both ordinary and advanced level subjects is 100. Lowest passing mark in ordinary level subjects is 45. Lowest passing mark in advanced level subjects is 40. Marks from 30 to 39 inclusive in the advanced level subjects are considered a pass at the ordinary level.

Note 2: Highest grade in both ordinary and advanced level subjects is1. Lowest passing grade in ordinary level, as well as advanced level subjects is 6. Grades 7 & 8 in advanced level subjects are considered a pass at the ordinary level.

Note 3: Grades A, B, C, D, E and O are grades of pass in descending order of merit for ordinary level subjects. For advanced level subjects, Grades A to E are passing grades in order of merit. Grade O in advanced level subjects, is considered a pass at the ordinary level.

8. The above student took the Scholastic Aptitute Test and the Achievement Tests given by the College Entrance Examination Board of Box 592, Princeton, New Jersey, U.S.A., administered by their examination centre in Baghdad in March/December/February/May 19 . His or/her marks in these Test were as follows:

Scholastic Aptitute Test (SAT)		Achievement Tests			
Verbal	Mathematical	English	Advanced Math.	Physics	Chemistry.
.../800	.../800	.../800	.../800	.../800	.../800

Note: Highest mark is 800, Lowest mark is 200.

9. The above candidate has also passed the Iraq State Baccalaureate Examination for Secondary Education, Scientific/Commercial/Section, in June/September 19 ranking among candidates from Shamash Secondary School and among candidates from all Schools in Baghdad/Iraq.
He/She is now eligible for entry into any higher institute of University standard in Iraq . or . He/She is now eligible for entry into the College of Commerce or the School of Economics or the College of Literature of the University of Baghdad.

In addition to the above, Mr/Miss
sat or will be sitting in January 19 or in June 19 for the London University G.C.E. Examinations in Physics, etc.

at the ordinary level and in English Literature

at the Advanced level. The results of these examinations are expected to be announced by the British Council in Baghdad, sometime in the first half of next October/April. The above candidate has high hopes of passing in all of them.

Prior to his/her joining Frank Iny Intermediate/Primary School in October 19 , the above candidate/Mr/Miss
did six/seven or years of Primary Schooling at/the old-established Alliance School in Baghdad which was united with Frank Iny Primary School in October 1951,/or/Frank Iny Primary School,/or/ Menahem Daniel Primary School.

(cont'd.p.5)

Date: / /

While in Frank Iny School and Shamash Secondary School, both of which are under the same administration, the above candidate distinguished himself/herself as a brilliant student of very good character,/or/was always diligent and of good character. For more than one academic year/or/ During the academic years October 19 - June 19 , the above candidate was appointed by the School as the monitor of his/her class. On more than one occasion during the different stages of his/her studies in these two schools, he/she was chosen by his/her classmates as the exemplary student of his/her class, and was accordingly awarded a prize by the school. He/She also won many/or/other school prizes in different years/ or He/She also won school prizes on different occasions for excellence in his/her academic work.

His/Her/hobbies at School were sports: mainly swimming or tennis/or/basket ball, social service and dramatics. At one time he/she was an active member of the School's Bulletin Committee.

At present Mr/Miss
is attending the Fifth/Fourth Form of Shamash Secondary School/Third Form of Frank Iny Intermediate School, and is doing extremely well/ or and is making good progress. In June 19 he/she will be sitting the Iraq State Baccalaureate Examination for Secondary Education, Scientific Section/Commercial Section. To judge by his/her Secondary School record, he/she should be able to pass this examination with distinction/satisfactorily/ or in due course, or he/she stands a good chance of passing this examination. He/She will then be eligible for entry into any higher institute of University Standard in Iraq, or and in case of passing, he/she will then be eligible for entry into/any higher institute of University standard in Iraq/ The College of Commerce or the School of Economics or the College of Literature of the University of Baghdad.

Mr./Miss is physically and mentally quite fit. I recommend him/her for/admission/higher studies to any University abroad as an excellent candidate/or without reserve/ or as a fairly good candidate.

Mr/Miss is supplied with this certificate at his/her own request.

Should Mr/Miss be admitted to an institute of University Standard, he/she might be able to pull along successfully.

A.S. OBADIAH,
for Principal.

SHAMASH SECONDARY SCHOOL

Date: 196

TO WHOM IT MAY CONCERN

This is to certify that Mr/Miss/
sat successfully the Iraq State Baccalaureate Examination,/Scientific Section,/ Commercial Section,/ in June this year, 196 , having obtained the following marks in the different subjects:

Subject	Mark%
Arabic Language.....................	
English Language....................	
Solid Geometry	
Botany & Zoology	
Algebra & Trig.	
Chemistry	
Physics	
Arabic Language.....................	
English Language & Correspondence...	
Business Methods & Commercial Law...	
Commercial Arithmetic...............	
Commercial Geography	
Book-keeping & Accountancy..........	
Economics	
Total out of ( )	
Average mark in all subjects........	
No.of students in class.............	
Rank of student in class............	

Marking System followed in the Baccalaureate Examinations for Secondary Education:

1. Maximum mark is: 100
2. Minimum passing mark in each subject is: 50.
3. Honour mark in each subject is 85-upward.
4. Average mark in all subjects, qualifying for admission to the University of Baghdad is: 67- upward.

While in Shamash Secondary School, Mr/Miss/
was always diligent and of good character/ distinguished himself/herself/ as a brilliant student of good character. His/Her punctuality in attending this school is noteworthy.

I recommend him/her for admission to any university abroad/for higher studies abroad as a fairly good/ as an excellent/ as a fair candidate.

He/She is supplied with this certificate at his/her/own request.

A.S. Obadiah,
Principal.

P H Y S I C S

Introduction :- We live in a world full of natural phenomena which always repeat themselves before us affecting either our senses of hearing or our sense of sight, or our sense of touch, etc.... . Man since the very primitive ages, could not but try to find explanation to those phenomena. Living beings, animals & plants, for example afford a good source of observation and a subject for study to the biologists. Similarly phusists and chemists are engaged to present explanations to the different phenomena that take place on matter, such explanations that can be accepted by the human mind; and thereupon to make use of these inferences in our practical life, to construct machines, to make medicine, etc...... for man's good.

But Physics is that science which is to give scientific answers to such questions as the following :-

Why does a falling body move wiht an increasing speed ?
Why does an aeroplane fly ?
Why does a stick seem broken when part of it is immersed in water ?
Why does a boat float while a stone sinks ?
How does an electric bell ring ?
How does a wireless-set (Radio) operate ? etc........

The answers to these questions and the like come under the science of Physics; or in other words, Physics deals with the behaviour of matter when it is under the effect of external force.

Importance of Physics: The study of Physics is the story of man's slow release from the ignorance, fear and superstition that surrounded and engulfed him in former times; and his gradual development of the conviction that he himself can understand and in which he can, to some extent, control the world and his destiny.

The study of Physics is indeed of enormous practical importance for the daily life of every man. It, at the same time, goes far beyond this. It has taught man not to fear his surroundings but by understanding them to control them. It has taught him that by scientifically examining his superstition he can banish his fears. And what does this scientific method involve ? It involves refusing to conduct our lives according to prejudice, emotion, whim, or superstition. It involves that we do not give judgement until we know all the facts. There is no study that gives a better training in the use of the scientific method that the study of the elements of Physics.

\- - - - - - - - - - - -

Properties of Matter :- Matter is anything that occupies space and has weight; and generally has the following properties :-

(a) It occupies space.

(b) It cannot be destroyed.

(c) It can be divided to a limited extent. For instance, if you take a piece of brick, and start crushing it, you will be able to make it into small particles like powder. If you go on crushing these small particles, you will reach a stage when you will no longer be able to crush the particles any further.

(d) It can be found in different forms, or states, such as solids, liquids & gases, Examples :- iron, water, & oxygen respectively.

(e) Matter usually affects one or more of our senses. Examples :-
The table affects our sight.
Chlorine affects our sense of smell.
The wind affects our sense of touch.

Three states of matter :- We stated above that matter can be found in different states, and these are as follows :-

Solids: These have definite size and shapes, e.g.: The black board.

Liquids: These have definite volumes but have variable shapes, they will have the same shape as the shape of the vessel in which they are contained. e.g.: water.

(cont'd. P.2)........

<u>Gases:</u> These have variable volumes and shapes. e.g. Air. They will always have the same volume and shape of the space they fill.

A matter can be changed from one state to another. For instance, if we heat a piece of ice (solid), it will change into water (liquid). And if we heat the water thus formed it will start to boil and change in to vapour (gas).

We give the following names to the fifferent changes that take place on the state of the matter.

1. Melting: When a body changes from the solid state to the liquid state.
2. Freezing : When a body changes from the solid state to the liquid state to the solid state. It is just the opposite of Melting.
3. Vaporization: When a body changes from the liquid state to the gaseous state.
4. Condensation: When a body changes from the gaseous state to the liquid state. It is just the opposite of vaporization.

If you consider a piece of ice heated on a fire, you will have the following changes in order: Melting and Vaporization, but if you consider some vapour cooled down, you will have the following changes in order: Condensation and Freezing.

MEASUREMENT

In our daily-life we always come across such problems; what is the length of a room? What is the weight of a certain body? How long did some one live? In order to overcome these difficulties we must find certain means to give clear answers to the above questions. This means is the adoptation of Measurement.

Measurement is therefore the finding of units for length , mass and time.

There are two systems for Measurement.

1. <u>The British System:</u> Which is adopted mainly in England and in the Dominions.

a. <u>Units of Length:</u> The British Unit of length is the <u>foot</u> (ft).

3 feet (ft) = 1 yard (yd)

1760 yards (yds) or 5280 ft = 1 mile.

$\frac{1}{12}$ ft. = 1 inch.

b. Unit of Mass :-

The British unit of mass is called the pound (lb).

2240 lbs = 1 ton.

c. Units of Time:-

The Unit of Time in the British System is the second.

60 seconds = 1 minute

60 minutes = 1 hour.

2. <u>The Metric System:-</u>

This system is used in France and other parts of Europe. It is more widely used than the British system.

a- <u>Units of Length:</u> The unit of length is called the metre which is equal to $\frac{1}{40,000,000}$ of the circumference of the Globe at the Equator.

Continued. p. 3.

$\frac{1}{10}$ of a metre = 1 decimetre (dcm)

$\frac{1}{100}$ of a metre = 1 centimetre (cm)

$\frac{1}{1000}$ of a metre = 1 millimetre (mm)

10 metres = 1 decametre

100 " = 1 hectometre

1000 " = 1 kilometre

b. <u>Units of Weight :-</u>

The unit of weight is called the <u>Gram</u> (gm) which is the weight of 1 cubic cm of distilled wated at 4°C. (Centigrade)

1000 gm = 1 kilogram (kg)

$\frac{1}{1000}$ gm = 1 milligram (mgm)

c. <u>Units of time :-</u> (The same as in the British System)

Some useful relations between the British & Metric System:

1 inch = 2.54 cm .

1 lb = 0.45 kg.

1gallon= 4½ litres.

5miles = 8 kilometres

DENSITY & SPECIFIC GRAVITY

If we take one kilogram of wood and another of iron we find that the vol. of wood is bigger than that of iron. In like manner if we take equal volume of wood & iron, we can find that the iron weighs much more than the wood. The reason for this difference in volume is because the cubic cm. of iron weighs more than the cubic cm. of wood, and in Physics, iron is called DENSER than wood.

We therefore have the word <u>DENSITY</u> which is the property of a matter which tells us how much a unit of volume actually weighs or is mass per unit vol.

In Metric System the <u>DENSITY</u> is the weight of a cubic cm. in grams; while in British System it is the weight of a cubic feet in lbs.

If we take a body of aluminium having a volume of 100 c.c. which will be found to weigh 270.0 gm., we find that every cubic cm. weighs $\frac{270}{100}$ = 2.7gm./c.c. which is the density of aluminium in Metric System.

We can thus say that :-

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

And if we give the symbols :-

D for Density. V for Volume. M for Mass.

We can write the following formula :- $D = \frac{M}{V}$ (for both Systems)

<u>Finding Densities :-</u>

a. <u>Of Solids :-</u>

In order to find the density of any solid, we have to weigh it first, then we must firnd its volume, which can be measured easily if it is a regular solid such as a cube, a prism, a sphere, etc..... .

The volumes of such a regular soild is easily calculated if we measure its dimensions. But how can we obtain the volume of an irregular solid? We all realize that as a solid is lowered into water the level of the latter rises.

(Continued P.4)......

If the water is in a measuring cylinder, i.e., a glass vessel graduated to indicate volume in c.c.or in cub.in.,and a body is lowered into it until totally immersed, the change in reading of the water level will indicate the volume of the solid. If the solid dissolved in, or reacts with water another suitable liquid must be used.

b. of Liquids:- To find the density of a liquid take a vessel of given volume (called specific gravity bottle). Weigh it empty; then fill it with the liquid and weigh it again.

The difference in weight gives the weight of the liquid. Divide this weight by the volume of the vesse, you get the density.

c. Of Gases:-

Take a glass sphere provided with a tap. Fill it with the gas and weigh Then evacuate it by an air pump and weigh again. The difference in the weight gives the weight of the gas. Divide this weight by the volume of the vessel which you can determine by weighing the amount of distilled water which fills the sphere.

To compare the Densities of some well-known matters, we have :-

Water	Aluminium	Lead
1 gm/ c.c.	2.7 gm/c.c.	11.3 gm/c.c.
62.4 lb/cu. ft.	168.75 lb/cu.ft.	706.25 lb/cu.ft.

We notice from above that aluminium is 2.7 times denser than water and this is true in both systems. In physics we call the number 2.7. which is the ratio of the densities of aluminium and water as the SPECIFIC GRAVITY of aluminium.

$$\therefore \text{SPECIFIC GRAVITY of a matter } (x) = \frac{\text{Density of Matter } (x)}{\text{Density of Water}}$$

or: Density of Matter (x) = Its Specific Gravity x Density of water or more generally we have:

$$\text{Specific Gravity} = \frac{\text{Mass of a certain volume of a substance}}{\text{Mass of the same volume of water}}$$

Or in words: It is the ratio of the mass of any volume of a substance to the mass of an equal volume of water.

The Specific Gravity is abreviated as S.G.

In order to find the Specific Gravity of a substance we must have a volume of the substance and an equal volume of water we divide the weight of the substance by the weight of water to get the S.G. of the substance.

Of all solids platinum has the highest G.G. while cork the least.
Of all liquids mercury has the highest S.G. while ether the least.
Of all gases chlorine has the highest S.G. while hydrogen the least.

Worked Examples.

1) A rectangular block of wood measures 100 cm. x 40 cm. x 15 cm. If it weighs 48 kg. Find its density and its specific gravity. The volume of the block = 100x40x15 = 60000c.c.
The weight of the block = 48 x 1000 = 48000 gms.
Since $D = \frac{M}{V}$ $\therefore D = \frac{48000}{60000} = 0.8$ gm./ c.c.

Solution :-

Wt. of water = 70.22 - 20.12
= 50.10 gm.
Wt. of liquid = 95.27 - 20.12
= 75.15 gm.
But since volume of liquid = volume of water.

$\therefore$ S.G. of liquid = $\frac{75.15}{50.1}$ = 1.5

Examples I

1. A bottle filled with water weighed 100g. The bottle empty weighed 20g. Find the capacity of the bottle in cubic centimetres ?
2. A flask holds 2520 g. of glycerin when filled. What is the capacity of the flask? S.G. 1.26.
3. A 10-c.c. graduated cylinder weighs 19.43 gm. empty and 155.89 gm. when full of mercury. What is the density of mercury ?
4. A rectangular block of wood measures 150cm.x40cm.x14cm. If it weighs 67.2 kilograms, what is its density ?
5. Find the weight of a column of mercury of height 30 inches & cross section 1 sq. inch (S.G. of mercury = 13.6)
6. A bottle weighs Xgm. Full of water it weighs Ygm. Full of milk it weighs Zgm. What is the density of milk ?
7. Find the S.G. of salt solution from the following data :-
   Wt. of bottle - 20.12 gm. Bottle + water, 70.82 gm. Bottle + solution, 71,72gm.
8. A vessel filled with an overflow pipe is full of water. A piece of rock of weight 100lb. & specific gravity 2.5 falls into it. What weight of water overflows and what volume does it occupy? (Density of water 62.5 lbs, per cu. ft.).
9. Find the density of a mixture containing 40c.c. of water and 60c.c. of oil of S.G. = 0.8
10. A piece of steel wire of length 24in. and cross-section 0.2 sq.in. weighs 1.12lb. What is its specific gravity ?
11. A bottle weighs 40gm. when empty and 120gm. when filled with water & 130 gm. when filled with equal volumes of water and oil. Find the density of the oil ?
12. A bottle weighs 15gm. when empty and 151gm. when filled with mercury and 33gm. when filled with salt solution. Find the density of the solution ?
13. Explain how the specific gravity of a liquid can be found by using a specific gravity bottle. A specific gravity bottle weighs 40gm. when empty and 240gm. when filled with water. When 260 gm. of sand is placed in the bottle, which is then filled up with water, the total weighs of the bottle and contents is 400gm. What is the specific gravity of sand ?
14. A specific gravity bottle weighs 20gm. when empty and 70gm. when filled with water Sand, weighing 20gm. is put into the empty bottle, which is then filled up with water, the total weight being 82gm. Calculate the specific gravity of the sand?
15. A closed glass flask weighs 72.59gm. and it weighs 72.01gm. when partially evacuated. It is then opened under water and 450c.c. of water enter the flask. Calculate the density of air under these conditions ?

PRESSURE IN LIQUIDS

LIQUID PRESSURE BENEATH A FREE SURFACE.

Definition of Force :- In order to lift a kilogram of mass we must use an upward push or pull. The greater the mass, the greater is the force which we must use. Also if a body is moving we can bring it to stop if we use a push in a direction opposite to the direction of movement of the body. This push or pull is called FORCE.

Force is therefore defined as: Anything is capable to move a body from rest or to bring it to stop if it is moving.

Unit of Force: Inthe british System the unit of force is the pound which is the force required to lift, or maintain a mass of 1 lb. In the Metric System it is the gram which is the force required to lift or, maintain a mass of 1gm.

Force beneath the Surface of Liquid:-

When a liquid is contained in a vessel, it exerts a force on the base of the vessel. This force is due to the mass of the liquid. The force per unit of area is called Pressure.

If we imagine that a vessel contains water to a height of 1cm. then on an area of 1sq.cm. of the base, there is a weight of 1gm., or a pressure of 1gm. per sq. cm. If the vessel contains water to a height of 2 cms., then every square centimetre carries 2 cubic centimetres of water or two grams. The pressure will thus be 2 gms/sq. cm. Now if water is substituted by another liquid of higher density such as Mercury, then the force exerted on the base will be more.

From above, we can conclude the following rules :-

1. The pressure is directly proportional with the height of the liquid.
2. The pressure is directly proportional with the density of the liquid.

Therefore if :-

P stands for pressure,

D stands for density of liquid,

H stands for height of column of liquid.

Then, we have P=HxD.

If the area of the base of a vessel is equal to (A) then the total force (F) exerted on it is equal to the product of the area times the pressure per unit area. $\therefore$ F = PA.

W O R K E D   E X A M P L E S :-

Q./ A liquid of S.G. 1.7 is contained in a vessel having a base 20 x 30 cms. If the vessel is filled to a height of 15 cms, Find the pressure & total force on the base of the vessel ?

A./ Since the units are in the Metric System,

D = S.G. x 1 = 1.7 gm/c.c.

P = HxD = 15 x 1.7 = 25.5 gm/sq.cm.

Area of base = 20 x 30 = 600 sq. cm.

F = P x A = 25.5 x 600 = 15,300 gm.
or 15.3 Kgm.

(cont'd.P.7)........

Level of Liquids in Connecting Vessels: It is a familiar fact that when water is poured into a tea-pot it stands at exactly the same **level** in the spout as in the body of the tea-pot; or if it is poured into a number of connected vessels like these shown in the diagram, the surfaces of the liquid in the various vessels lie in the same horizontal plane.

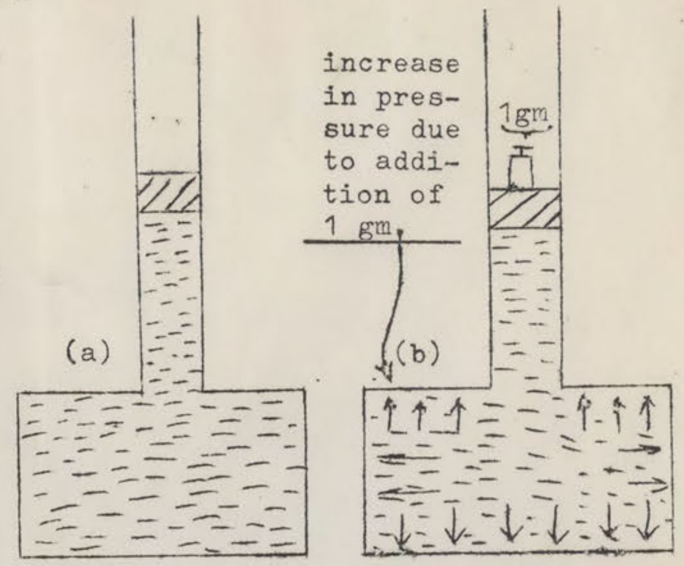
E X A M P L E I I

1. Find the force on a horizontal surface 2ft. by 4ft. submerged in water,(a) to depth of 2ft.; (b) to a depth of 4ft. ?
2. Find the pressures on the surfaces of the preseeding problem ?
3. Find the force on a horizontal surface 10 cm. sq. submerged in water to depth of (a) 10 cm.; (b) 100 cm.; (c) 100 m. ?
4. Find the pressure on the surfaces of the preceeding problem ?
5. A standpipe 100ft. high is filled with water. Determine the pressure at the bottom in pounds per square feet and in pounds per square inch ?
6. A hole 5 cm. sq. is made in a ship's bottom 7m. below the water line. What force in kilograms is required to hold a board above the hole ?
7. How high is a column of water that is supported by a pressure of 5 Kg/cm^2 ?
8. The area of the bottom of a tank is 100 sq. ft. The tank is filled with 126,000 lbs. of oil (S.G. = 0.8). Find the pressure in pounds per square inch on the bottom of the tank ?
9. What is the difference in pressure in the water pipes on two floors of a building, if one is 12 m. higher than the other ?
10. If the point of a lead pencil has an area of $\frac{1}{500}in^2$. and you push it against a piece of paper with a force of 2 lbs. How great is the pressure ?
11. The total weight of oil in an oil container is 28 Kg., and the area of the bottom of the container is 70 cm^2. If the S.G. of oil = 0.4 gm/c.c., what must be the depth of the oil ?
12. If the water pressure in the city mains is 70 lb/in^2., how high above the town is the top of the water in the standpipe ?

Pascal's Principle

Transmission of Pressure by Liquid :-

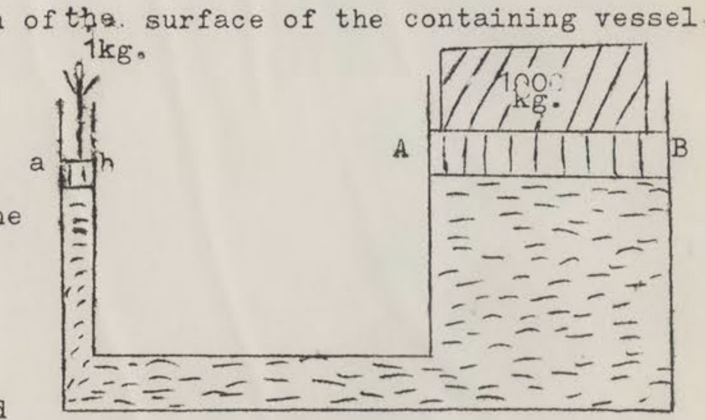
Let us imagine a vessel of the shape shown in figure (a) filled with water up to the level (ab). If we assume the upper portion to be 1sq.cm. in cross section. (cont'd.P.8)................



Then because the density of water is 1gm/c.c., the force with which it presses against any sq.cm. of the interior surface which is (h) centimetres beneath the level (ab) is (h)grams. Now if we add 1gm. of water (that is, 1 c.c.) to the tube, the pressure on any sq.cm. of the interior vessel will be increased by(1). If we now put a weight of 1gm. on the surface of water through a piston as in figure (b) the same result happens. It is to be noted that this increase of pressure of 1gm. per sq.cm. is not applicable only on the base, but on all the sides of the vessel as well, and the pressure on every square centimetre will be increased by 1gm.

We therefore arrive at Pascal's Principle which states :-

- The pressure applied anywhere to a body of confined liquid is transmitted in the same magnitude to every portion of the surface of the containing vessel.



Application of Pascal's Principle :-

Consider a vessel of the shape shown in the figure. If the area of the cross section of the cylinder (ab) is 1sq.cm. and that of the cylinder (AB) is 1000 sq.cm. a force of 1Kg. applied to (ab) would be transmitted by the liquid so as to act with a force of 1Kg. on each square centimetre of the surface (AB). Hence the total upward force exerted against the piston (AB) by the 1Kg. applied at (ab) would be 1000Kgs.

HYDRAULIC PRESS

An important application of Pascal's Principle is the Hydraulic Press as in(fig) which is a useful mechanical contrivance in which the pressure of water acting on a small arm A is transmitted equally to a large plunger B (Pascal's Principle) and since the area of the plunger is much larger than the arm, an enormous force can be exerted by the plunger for the purpose of pressing bales of cotton or binding books, etc...... .

(cont'd.P.9).........

كيمياء رقم ٧

الرمـوز والصيــــغ الكيمياويـــة

تتبع الخطوات التالية لايجاد الصيغة الكيمياوية للمركب :

(١) احسب النسبة المئوية للعناصر المكونة للمركب $\frac{\text{وزن العنصـــر}}{\text{وزن المركـــب}} \times ١٠٠$

(٢) اقسم النسبة المئوية لكل عنصر على وزنه الذرى فتحصل على نسب ذرات العناصـــر في الصيغة الوضعيـــة .

(٣) خذ اصغر النسب من الخطوة السابقة واقسم جميع النسب عليها ثم قرب الناتج الـــى اقرب عدد صحيح فتحصل على عدد ذرات العناصر المكونه للصيغة الوضعية .

(٤) اكتب الصيغة الوضعية للمركب من الخطوة اعـــلاه .

(٥) جد الوزن الجزيئي للصيغة الوضعية " من مجموع الاوزان الذرية للصيغة الوضعية " .

(٦) احسب الوزن الجزيئي للمركب " باحدى طرق ايجاد الوزن الجزيئي " .

(٧) اقسم الوزن الجزيئي للمركب على الوزن الجزيئي للصيغة الوضعية وقرب الناتـــج الى اقرب عدد صحيح فتحصل على مضاعفات الصيغة الوضعية .

(٨) الصيغة الجزيئية هي حاصل ضرب الصيغة الوضعية × مضاعفاتها .

١ـ يتركب غاز الايثان من ٨٠ ٪ من الكاربون ، ٢٠ ٪ من الهيدروجين فما الصيغـــة الوضعية لهذا المركب . اذا علمت ان الوزن الذرى للكاربون ١٢ والهيدروجين ١

٢ـ يتحـــد ١٠٠ غم من الحديد مع ٣٠ر١ لتر من الاوكسجين مقيسا في ظ . ق . فيتكون اوكسيد صلب . جـــد الصيغـــة الوضعيـــة لهذا الاوكسيد اذا علمت ان الوزن الذرى للحديـــد ٨٥ر٥٥ والاوكسجين ١٦

٣ـ مركب يتكون من ١ر٢٩ ٪ من الصوديوم ، ٥ر٤٠ ٪ من الكبريت ، ٤ر٣٠ من الاوكسجين اوجـــد الصيغـــة الوضعيـــة للمركب اذا علمت ان الوزن الذرى للصوديوم ٢٣ والكبريـــت ٣٢ والاوكسجين ١٦

٤ـ ما الصيغـــة الوضعيـــة لمركب يحتوى ٦٧ر٤٠ ٪ من الكاربون ، ٧٣ر٢٣ ٪ مـــن النتروجين ، ١٣ر٢٧ ٪ من الاوكسجين ، ٤٧ر٨ ٪ من الهيدروجين

٥ـ ملح مائي يحتوى ٣٢ر٤٩ ٪ من الماء ، ٢٦ر١٨ ٪ من الكالسيوم ، ٤٣ر٣٢ ٪ مـــن الكلور ماهي الصيغـــة الوضعيـــة للملح

يتبـــــــع ص ـ ٨

الحســـابات الكيمياويـــة

(١) ماوزن كاربونات الكالسيوم التي عند تسخينها التام تعطي ٢١ غم من الكلس الحي .

(٢) اذيب عشرة غرامات من اوكسيد الكالسيوم في الماء . ماوزن كاربونات الكالسيوم الناتجة من امرار كفاية من ثاني اوكسيد الكاربون عليه .

(٣) ماحجم النتروجين الجاف في ١٢ °م وضغط ٧٧٠ ملم / زئبق الناتج من تسخين ٣٫٢ من نترات الامونيوم .

(٤) اوكسيد الرصاص الاحمر Pt_3O_4 عند اتحاده مع حامض النتريك لاعطاء نترات الرصاص وثاني اوكسيد الرصاص PbO_2 . ماوزن فوق اوكسيد الرصاص الناتج من تفاعل ١٣٧ غم من الاوكسيد الاحمر .

(٥) اذيب وزن معين من الفضة في حامض النتريك ثم رسبت الفضة على هيئة كلوريد الفضة باضافة ملح الطعام . فاذا كان ١٫٢٣٤ غم من كلوريد الفضة قد ترسب في مقدار وزن الفضة في النموذج .

(٦) ماوزن كلوريد المترسب من اضافة لتر واحد من محلول ١٠٪ من ملح الطعام الى محلول نترات الفضــة .

(٧) عومل ٥٠ سم³ من حامض الكبريتيك مع محلول كلوريد الباريوم الساخن حتى تمام الترسيب وبعد غسل الراسب وتجفيفه وجد انه يزن ١٫١٦٥ غم . احسب تركيز الحامض في هذا المحلول .

(٨) اذيب ٢ غم ملح كلوبر $Na_2SO_4 \cdot 10H_2O$ في الماء ثم رسب باضافة كمية وافية من كلوريد الباريوم احسب وزن كبريتات الباريوم المترسبة .

(٩) احسب وزن اوكسيد الزئبق الاحمر الذي يعطي من الاوكسجين ما تعطيه ٥ غرامات من كلورات البوتاسيوم .

(١٠) ما مقدار وزن غاز الكلور بالغرامات التي يمكن الحصول عليها من تسخين ٥٠ غم من ثاني اوكسيد المنغنيز مع كفاية من حامض الهيدروكلوريك .

(١١) ما حجم ثاني اوكسيد الكاربون في ٢٧ °م و ٧٥٠ ملم / زئبق الذي يمكن الحصول عليه من تفاعل ١ غم من كاربونات الكالسيوم مع حامض الهيدروكلوريك المخفف .

(١٢) ١ غم من مخلوط كاربونات الكالسيوم واكسيد الكالسيوم عند معاملته مع حامض اعطى ١٩٠ سم³ من ثاني اوكسيد الكاربون في ١٥ °م و ٧٤٠ ملم / زئبق ، احسب النسبة المئوية للكاربونات في المخلوط .

(١٣) نموذج من كاربونات الصوديوم اللامائية التجارية يزن ٠٫٥٣ غم اعطى ١٠٢ سم³ من ثاني اوكسيد الكاربون في ظ . ق عند معاملته مع الحامض ، احسب وزن الشوائب في هذا النموذج .

(١٤) نموذج غير نقي من ثاني اوكسيد المنغنيز يزن ٥ غم يحرر ٩٠٠ سم³ في ظ . ق عند اكسدة كمية كافية من كلوريد الهيدروجين . احسب النسبة المئوية للاوكسيد النقي في النموذج .

(١٥) ما مقدار وزن ثاني اوكسيد الكاربون الذي عند امراره في محلول هيدروكسيد الكالسيوم الناتج من اضافة ١٤٫٥ غم من اوكسيد الكالسيوم الى الماء لتحويله الى كاربونات الكالسيوم وعند اضافة ٢٠٫٤ غم من كلوريد الهيدروجين الى المحلول . مامقدار غاز ثاني اوكسيد الكاربون الناتج عن التفاعل ومن اي المادتين يتخلف باق وما مقداره .

(١٩) تفاعلت ١٠٠ غم من محلول حامض الهيدروكلوريك مع كمية كافية من كاربونات الصوديوم فاعطت ٧ر٣٦ لتر من ثاني اوكسيد الكاربون تحت ظ.ق. فاذا علمت ان كثافة المحلول الحامضي تساوى ١ر١٢ غم/سم٣ . فاحسب عيارية الحامض والنسبة المئوية لغاز كلوريد الهيدروجين في المحلول .

(٢٠) وجد بالتجربة ان ٢٥ سم٣ من مخلوط حامضي الكبريتيك والهيدروكلوريك المخففين تعادل ٨ر٢٢ سم٣ من محلول هيدروكسيد الصوديوم العشر عيارى والنسبة بين وزني الحامضين في مخلوطهما هي ١ : ٣ على الترتيب. احسب وزن كل من الحامضين في لتر من محلولهما .

(٢١) ٣٨ر١٦ غم من حامض ثنائي القاعدة يحتوى على جزيئتين من ماء التبلور اذيب في الماء واكمل المحلول الى ٢٥٠سم٣. ٢٥ سم٣ من هذا المحلول احتاجت لمعادلتها ٢٦ سم٣ من عيارى كاربونات الصوديوم ، احسب :ـ

١ـ الوزن المكافيء لبلورة الحامض .

٢ـ الوزن الجزيئي للحامض اللامائي .

(٢٢) ٣ر٩ غم من صودا الغسيل اذيبت في الماء واكمل المحلول الى ٢٥٠ سم٣. ٢٧ر٣ سم٣ من عشر عيارى حامض الكبريتيك احتاجت لمعادلتها ٢٥ سم٣ من هذا المحلول احسب :ـ

١ـ النسبة المئوية لوزن كاربونات الصوديوم في النموذج .

٢ـ عدد جزيئات ماء التبلور في كاربونات الصوديوم .

(٢٣) وجد ان ٢٠ سم٣ من محلول يحتوى على ٥ر٦٢ غم/لتر من صودا الغسيل التجارية "$Na_2Co_3 . 10\ H_2O$" احتاجت لمعادلتها الى ٩٥ر١٣ سم٣ من نصف عيارى حامض الكبريتيك ، ما النسبة المئوية للنقاوة في المادة .

(٢٤) عند تخفيف حامض النتريك ٢٠ مرة وجد ان ٢٥ سم٣ من المحلول المخفف للحامض تحتاج لمعادلتها ٣٠ سم٣ من عشر عيارى هيدروكسيد الصوديوم. احسب تركيز حامض النتريك الاصلي بالغرامات في اللتر.

اذيبت بلورات من صودا الغسيل "كاربونات الصوديوم المائية" في الماء وكان المحلول يحتوى على ٣ر١٢ غم في كل ٢٠٠ سم٣ ثم وجد ان ٢٠ سم٣ من هذا المحلول تتعادل مع ٨ر٢١ سم٣ من محلول عشر عيارى لحامض الكبريتيك . احسب النسبة المئوية لماء التبلور في بلورات صودا الغسيل ؟

علل ما يلـــــي :

١ـ يوضع صوف الزجاج او الرمل الجاف او الزئبق في قعر الاسطوانة الداخليـة في تجربة فكتور مايـــر .

٢ـ لا يمكن تسييل غاز ثاني اوكسيد الكاربون في درجة اعلى من + ٣١ °م .

٣ـ ملح الطعام ملح لا مائي ورغم ذلك فان الملح المستعمل في البيوت يصبـح رطبا في الشتاء .

٤ـ ترتفع درجة غليان السائل وتنخفض درجة انجماده عند اذابة مادة غــير متطايرة فيــه .

٥ـ لا تستعمل الأوزان المطلقة لحساب الأوزان الذريــة .

٦ـ لا تستعمل طريقة راؤلت لايجاد الوزن الجزيئي لملح الطعام .

٧ـ الاوزان الذرية هي مجموع اوزان البروتونات والنيوترونات ورغم ذلك فنجـد ان الاوزان الذرية كســرية .

٨ـ لا يمكن تعيين مكافيء المغنيسيوم بطريقة حرقه في الهواء بقصد تحويله الـى اوكســيد .

٩ـ تحضر الحوامض ذات درجة الغليان الواطئة من املاحها مع حامض ذو درجـة غليان عالية ورغم ذلك لا يحضر حامض الكاربونيك بهذه الطريقـة .

١٠ـ لا تعتبر الكحولات من القواعد بالرغم من احتوائها على مجموعة او اكثـر من مجاميع الهيدروكسيل .

١١ـ تستعمل كاربونات الصوديوم الحامضيـة لازالة الحموضة الزائدة في المعدة .

١٢ـ يغير محلول كبريتات النحاس الزرقاء ورقة عباد الشمس الزرقاء الى حمراء .

١٣ـ بلورات كبريتات النحاس المتزهرة عديمة اللون والمتميه زرقـــــاء .

١٤ـ يعتبر هيدروكسيد النحاس قاعدة ولكنه لا يعتبر قلويــا .

(يتبع) ..

١٥ — يظهر راسب رمادى اللون عند اضافة كلوريد القصديروز الى كلوريد الزئبقيك ويسود هذا الراسب عند زيادة كلوريد القصديروز .

١٦ — يحضر الهيدروجين من تفاعل الخارصين غير النقي مع حامض الكبريتيك المخفف ولا يستعمل مع الحامض المركز .

١٧ — تكتسي برادة النحاس البنية اللون بلون ابيض براق عند وضعها في محلول احد املاح الزئبق .

١٨ — تحضر النورة من تسخين كاربونات الكالسيوم الى درجة لا تزيد على ١٢٠٠ م° ولا تقل عن ٩٠٠ م° .

١٩ — لا يمكن تعيين عيارية هيدروكسيد الصوديوم بأذابة وزن معين منه في حجم ثابت من الماء .

٢٠ — عند اذابة وزن جزيئي من CH_3COOH في الماء واكماله الى لتر تحصل على محلول عيارى للحامض بينما عند اذابة وزن جزيئي من $H_2C_2O_4$ في الماء واكماله الى لتر نحصل على محلول ٢ع من الحامض .

الصف الثالث المتوسط
للسنة الدراسية ١٩٦٩/١٩٧٠

Answer 8 questions

Advanced Level
Mathematics 1
Pure Mathematics
Specimen Paper on 1968 Syllabus.

Time allowed:
Three hours

(1)i. Find the values of λ for which the equation in x

$$x^2 - x + 1 = \lambda(x^2 + x + 1),$$

where $\lambda \neq 1$, has equal roots and find, also, the range of values of λ for which the roots are real and unequal.

If one of the roots is four times the other, find them.

ii. Find the positive values of x and y which satisfy the simultaneous equations.

$$\log_y x + \log_x y = 2\tfrac{1}{2},$$
$$x + y = 12.$$

(2)i. If x^4 and higher powers of x are neglected, find by how much $\sqrt[3]{1+x}$ differs from $1 + \frac{1}{3}x - \frac{1}{9}x^2$ and hence evaluate $\sqrt[3]{1010}$ to five decimal places.

ii. Prove by induction that 6 is a factor of $n(n + 4)(n + 5)$ for all positive integral values of n.

(3)i. Express in the form x + iy

(a) $(3 + 2i)(2 - i)$,

(b) $(3 + 2i)/(2 - i)$,

(c) $(1 - i\sqrt{3})^3$.

Show the complex numbers $(3 + 2i)$ and $(2 - i)$ on an Argand diagram and on it show how the results to (a) and (b) can be obtained geometrically.

ii. If P is the point in an Argand diagram representing the complex number z and if $|z - 1| = 2|z - 2|$, find the locus of P.

(4) Prove that the equation of the circle on the line joining the points (x_1, y_1) and (x_2, y_2) as diameter is

$$(x - x_1)(x - x_2) + (y - y_1)(y - y_2) = 0$$

O is the origin. A the fixed point (a, 0), where a is positive, and P a point on the positive part of the y-axis such that the angle OAP= θ. Q is a point in the first quadrant such that PQ is perpendicular to AP and equal in lenght to ½AP. Find the coordinates of Q in terms of a and θ and determine the locus of Q as θ varies.

Show also that as θ varies the circle on AQ as diameter passes through a fixed point on the y-axis, and find the coordinates of that point.

(5) Find the equation of the chord joining the points $(ap^2, 2ap)$ and $(aq^2, 2aq)$ on the parabola $y^2 = 4ax$.

PQ is a chord of this parabola passing through the focus S(a,0). PM and ONare drawn perpendicular to the line x + a = 0 meeting it at M and N respectively. Prove that

(a) PN and QM pass through the origin,

(b) MN subtends a right angle at the focus,

(c) the tangents to the parabola at P and Q form with SM and SN a rectangle, one vertex of which lies on MN.

(6)i. Find the limit as θ tends to 0 of

$$\frac{1 - \cos 2\theta}{1 - \cos \theta}.$$

ii. A and B are positive acute angles such that $2A - B = \frac{\pi}{4}$.

If $\tan B = 1/239$, find $\tan A$ without using tables.

iii. Show that $\cot(\theta + 75) - \tan(\theta - 75) = \frac{4\cos 2\theta}{1 + 2\sin 2\theta}$

(7) Find the general solutions of the equations

(a) $\sin^2 7\theta - \sin^2 6\theta = \sin^2 \theta$,

(b) $5\cos 2\theta + 12 \sin 2\theta = 9$,

(c) $3\cos 2\theta + \sin \theta - 1 = 0$.

(8)i. State De Moivre's theorem and use it to prove that

$$\sin 6\theta = \sin 2\theta(4\cos^2\theta - 1)(4\cos^2\theta - 3).$$

ii. Express the roots α and β of the equation $x^2 - 2x + 4 = 0$ in the form $r(\cos\theta + i\sin\theta)$. Hence obtain α^6 and β^6 and form the equation whose roots are α^6 and β^6.

(9) If $f'(x) = \frac{2 - x}{x^2}$ and $f(1) = 0$, find $f''(x)$ and $f(x)$, the dashes denoting differentiations with respect to x.

Show that the graph of $f(x)$ has only one turning point and find, correct to two decimal places, the value of the function at that point, stating whether it is a maximum or a minimum value.

Show that $f(4)$ and $f(5)$ have opposite signs, and draw a rough sketch of the graph of $f(x)$.

(10) The curves $y^2 = x$ and $x^2 = 8y$ intersect at the origin O and at a point P. The tangent at P to the first curve meets the y-axis in H and the tangent at P to the second curve meets the x-axis in K. Prove that OP bisects HK.

Find

(a) the area between the two curves,

(b) the volume obtained by rotating this area completely round the x-axis.

Answer 8 questions | Advanced Level Mathematics II Pure Mathematics | Time allowed: Three hours.

1. (i) The rth term is $ar + br^2$, where a and b are constants. Find the sum to n terms.

A series is of the above form, the sums to three and five terms respectively being 180 and 690. Determine the fourth term.

(ii) Find the real factors of $x^4 + x^2 + 1$.

Sum to n terms the series whose qth term is $\dfrac{q^4 + q^2 + 1}{q^4 + q}$.

2. (i) Show that, for all values of x and y,

$$x^2 + xy + y^2 \geqslant 0.$$

Deduce that $(x + y)(x^3 + y^3) \leqslant 2(x^4 + y^4)$.

(ii) If p, q, r and s are positive numbers, prove that

$$(p + q)\left\{\frac{1}{p} + \frac{1}{q}\right\} \geqslant 4$$

and that

$$(p + q + r + s)\left\{\frac{1}{p} + \frac{1}{q} + \frac{1}{r} + \frac{1}{s}\right\} \geqslant 16.$$

3. (i) The equations

$$6x^3 - 2x^2 + 11x + 10 = 0$$

and

$$12x^3 + 11x^2 + 20x + 12 = 0$$

have a common root. Find it.

(ii) The roots of the equation $x^3 + px + q = 0$ are α, β, and γ.

Find the equation whose roots are

(a) $(\beta+\gamma)^3$, $(\gamma+\alpha)^3$, $(\alpha+\beta)^3$,

(b) $\dfrac{\beta}{\gamma}+\dfrac{\gamma}{\beta}$, $\dfrac{\gamma}{\alpha}+\dfrac{\alpha}{\gamma}$, $\dfrac{\alpha}{\beta}+\dfrac{\beta}{\alpha}$.

4. (i) If $\quad = \cos\frac{2\pi}{3} + i\sin\frac{2\pi}{3}$, expand in ascending powers of x,

$$(1 + x)^{3n} + (1 + \omega x)^{3n} + (1 + \omega^2 x)^{3n},$$

where n is a positive integer.

(ii) Solve the equation $(1 - z)^3 = 8(1 + z)^3$, expressing your results in the form $a + ib$.

5. Prove that $\cos 75 = \dfrac{\sqrt{3} - 1}{2\sqrt{2}}$ and that $\tan 75 = 2 + \sqrt{3}$.

A right pyramid has for its base a regular dodecagon (12-sided polygon) of side 2a . The lenght of each slant edge of the pyramid is 5a .

Prove that

(a) the inclination of a slant face to the base is $\cos^{-1}\left\{\dfrac{2 + \sqrt{3}}{2\sqrt{6}}\right\}$,

(b) the inclination of a short edge to the base is

$$\cos^{-1}\left\{\frac{\sqrt{6} + \sqrt{2}}{5}\right\}.$$

If ϕ is the angle between two slant adjacent faces, find $\cos\phi$.

6. $P(a\cos\theta,\ b\sin\theta)$, $Q(a\cos\phi,\ b\sin\phi)$ and $R(a\cos\psi,\ b\sin\psi)$ are points on the ellipse $\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2} = 1$ such that PQ and PR are chords through the foci (ae, 0) and (−ae, 0) respectively. Prove that

$$\cos\frac{\theta - \phi}{2} = e\cos\frac{\theta + \phi}{2} \text{ and that } \tan\frac{\phi}{2}\tan\frac{\psi}{2} = \cot^2\frac{\theta}{2}.$$

N is the foot of the perpendicular from P to the x-axis. QR meets the x-axis at T, and C is the centre of the ellipse. Prove that the rectangle TC.CN is constant.

7. Find the equation of the normal ... rectangular hyperbola $xy = c^2$.

P is a point on the hyperbola and P' is the opposite end of the diameter PP'. The normal at P' meets the hyperbola again at Q. Find the loci of

(a) the centroid of the triangle PP'Q,

(b) the midpoint of PQ.

8. Find the coordinates of the point of intersection of the lines

$$\frac{x+1}{2} = \frac{y+4}{3} = \frac{z-1}{1},$$
$$\frac{x-3}{2} = \frac{y+2}{-1} = \frac{z-1}{-1},$$

and find also the equation of the plane containing these two lines.

9. (i) Differentiate $\sin^{-1}\left\{\sqrt{\left(\frac{x-1}{x+1}\right)}\right\}$ with respect to x.

(ii) Find $\int \cos 3\theta \sin^n \theta \, d\theta$, where n is a positive integer.

(iii) Evaluate $\int_0^{\frac{\pi}{4}} \phi \sec^2 \phi \, d\phi$.

10. (i) Find the maximum and minimum values of $\frac{x}{x^2+1}$ and distinguish between them.

(ii) Show that the values of x for which the tangents to the curve $y = x \cos x$ are parallel to the x-axis are roots of the equation $x = \cot x$.

Use tables to find the smallest positive root of this equation and sketch the graph of y for $-\frac{1}{2}\pi \leqslant x \leqslant \frac{1}{2}\pi$.

Formula of Pascal's Principle :-

If f stands for the force on the small piston.

F stands for the force on the large piston.

a the area of the small piston.

A the area of the large piston.

$\therefore \frac{f}{a}$ = the pressure on the small piston;

and $\frac{F}{A}$ = the pressure on the large piston; and because these pressures are equal: $\therefore \frac{f}{a} = \frac{F}{A}$.

WORKED EXAMPLE.

Q. The piston in a hydraulic press have radii 2 in. and 25 in. If a weight of 30 lbs acts on the small one, what load will be supported by the other ?

A. Area of small piston $= \pi r^2$

$$= \pi (2^2) = 4 \pi \text{ in}^2$$

Area of large piston $= \pi R^2$

$$= \pi (25^2) = 625 \pi \text{ in}^2$$

Pressure per inch square on small piston $= \frac{f}{a} = \frac{30}{4\pi}$, and this is equal to the pressure on the large piston, $\therefore$ Total force on large piston :-

$$= \frac{30}{4\pi} \times 625\pi = \frac{30 \times 625}{4} = \underline{4687.5 \text{ lbs.}}$$

Or applying the formula: $\frac{f}{a} = \frac{F}{A}$: $\frac{f}{r^2 \pi} = \frac{F}{R^2 \pi}$

$$\frac{30}{4} = \frac{F}{625}$$

$$\therefore F = \frac{625\pi \times 30}{4\pi} = \frac{18750}{4} = \underline{4687.5 \text{ lbs.}}$$

EXAMPLE III

1. Two pistons of a hydraulic press have areas of 2 and 70 in^2 respectively. What force applied to the small piston will overcome a resistance of 35000 lbs on the large piston ?

2. A man exerts a force of 50 lbs on one piston of a hydraulic press whose area is 0.5 in^2. What pressure does he cause in the liquid ? What force does the liquid exert on the other piston whose area is 6 in^2 ?

3. A bottle full of water is closed by a stopper whose area is 3 cm^2. The area of the base of the bottle is 40 cm^2. When a force of 27 lbs pushes on the stopper, what is the force caused on the base of the bottle ?

(cont'd.P.10)......

Formula of Pascal's Principle :-

If f stands for the force on the small piston.

F stands for the force on the large piston.

a the area of the small piston.

A the area of the large piston.

$\therefore \frac{f}{a}$ = the pressure on the small piston;

and $\frac{F}{A}$ = the pressure on the large piston; and because these pressures are equal: $\therefore \frac{f}{a} = \frac{F}{A}$.

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(cont'd.P.10)......

January 1965

Ordinary Level

ADDITIONAL MATHEMATICS (3)

THEORETICAL MECHANICS

GENERAL CERTIFICATE OF EDUCATION
EXAMINATION

January 1965

Ordinary Level

ADDITIONAL MATHEMATICS (3)

THEORETICAL MECHANICS

Two hours

Answer any SIX questions.

Credit will be given for the orderly presentation of material: candidates who neglect this essential will be penalized. All necessary working must be shown.

Take g as 32 ft per sec per sec.

1. Forces of magnitude 1, 4, 3 and 5 lb wt act along the sides AB, BC, CD and DA respectively of the square ABCD in the senses indicated by the order of the letters. AB is 12 inches long and the line of action of the resultant of the forces cuts AD produced at X. Calculate the magnitude of the resultant, the angle its line of action makes with AD and the length of AX.

2. ABCD is a square uniform plate and E and F are the mid-points of AB and BC respectively. The corner EBF is cut off and the plate freely suspended from A. Calculate the angle which AD makes with the vertical.

3. A non-uniform rod AB weighs 30 lb and hangs in a vertical plane supported by two strings AC and BC attached to a peg C. AB = 10 in., AC = 12 in. and BC = 8 in. If, in the position of equilibrium, AB makes an angle of 30° with the horizontal find, by drawing or by calculation,

   (a) the distance of the centre of gravity of the rod from A,
   (b) the tensions in the strings.

4. A body of mass 15 lb is on the point of slipping down a plane when the inclination of the plane is 25°. If the inclination of the plane is reduced to 15° find the least force, acting parallel to the plane, necessary to move the body

   (a) up the plane,
   (b) down the plane.

5. A stone is thrown from the top of a cliff 112 ft above sea level with a speed of 120 ft per sec at an elevation θ. If $\tan\theta = 4/3$ find how far from the foot of the cliff the stone enters the sea and the direction of flight at that instant.

6. A car of mass 15 cwt freewheels down a slope of 1 in 20 (i.e. $\sin^{-1} 1/20$) at a uniform speed of 20 m.p.h. Find, in lb wt, the resistance to motion.

   On reaching level ground the engine is switched on and works at 15 horse power. Assuming the resistance to motion to be unchanged, find the initial acceleration of the car.

7. A bullet of mass 3 oz is fired with a horizontal velocity of 1,200 ft per sec from a gun of mass 70 lb. If the gun is free to move from rest find its momentum and kinetic energy as the bullet leaves the muzzle.

   If the gun fires 250 such bullets per minute find the average force required to keep it at rest.

8. A railway truck of mass 10 tons is travelling at 30 m.p.h. on a curve of radius 300 yards. If the rails are on a horizontal plane find the horizontal thrust exerted by the rails on the truck and state its direction.
   If the distance between the rails is 4 ft 8½ in. find how much the outer rail must be raised so that the lateral thrust of the rails on the truck is eliminated.

Terms used in Arithmetic

المصطلحات المستعملة في الحساب

1. To count	١ـ العد (عد يعد * عدا)
2. Number	٢ـ عدد
3. Figures= Numberals	٣ـ ارقام
4. Symbcls	٤ـ رموز
5. A concrete number	٥ـ عدد معين (له وحدة معينة)
6. An abstract number	٦ـ عدد مجرد عن الوحدة (مثل النسب المثلثية)
7. Numeration	٧ـ التعداد ـ الترقيم
8. Notation, (to denot#)	٨ـ تمثيل الاعداد بالارقام (يمثل ب)
9. Naught= cipher= Zero= 0.	٩ـ الصفر .
10. One= unity= a unit	١٠ـ الوحدة
11. digit, (plural, digits)	١١ـ مرتبة (جمعها مراتب)
12. The decimal system	١٢ـ النظام العشرى
13. Unit's place	١٣ـ رتبة الآحاد
14. Ten's place	١٤ـ رتبة العشرات
15. Hundred's place	١٥ـ رتبة المئات
16. Addition	١٦ـ الجمع
17. Sum= total= sum-total= amount	١٧ـ حاصل الجمع
18. The sign of addition,is the plus sign(+)	١٨ـ علامة الجمع هي علامة الزائد (+)
19. The sign of equality, is (=) read equals	١٩ـ علامة المساوى (=)
20. Subtraction	٢٠ـ الطرح
21. The difference of two numbers	٢١ـ الفرق بين عددين=حاصل طرح عددين
22. Complementary addition	٢٢ـ الطرح بالمتمم الحسابي
23. Subtrahend	٢٣ـ المطروح
24. Minuend	٢٤ـ المطروح منه
25. The sign of subtraction, is the minus sign(-)	٢٥ـ علامة الطرح هي علامة الناقص(ـ)
26. The difference or the remainder	٢٦ـ ناتج الطرح =باقي الطرح
27. Multiplication	٢٧ـ الضرب
28. Multiplicand	٢٨ـ المضروب
29. Multiplier	٢٩ـ المضروب فيه
30. Product	٣٠ـ حاصل الضرب
31. Partical Products	٣١ـ حواصل الضرب الجزئية
32. Factors	٣٢ـ العوامل
33. The sign of multiplication, is the cross sign (x)	٣٣ـ علامة الضرب هي العلامة (×)
34. The commutative law in addition & multiplication. Example: 5+6= 6+5 ; 5x4=4x5; a.b=b.a	٣٤ـ قانون الابدال في الجمع والضرب مثال : ٥+٦=٦+٥ ، ٤×٥=٥×٤ ، ا.ب = ب.ا
35. The Distributive or associative law in addition & multiplication Example: a+b-c=(a+b)-c=(a-c)+b etc..; c(a+b)=ca+cb etc...	٣٥ـ قانون التوزيع في الجمع والضرب مثال : ا+بـ ـجـ = (ا+ب)ـجـ = (اـجـ)+ب الخ ... ، جـ(ا+ب) = جـا+جـب الخ ..
36. The factor Law Example: a(b.c)=(a.b)c=b.c.a., etc...	٣٦ـ قانون العوامل ، مثال : ا×(ب×جـ) = ا×ب×جـ = ب×جـ×ا
37. Multiplication table	٣٧ـ جدول الضرب

38. Proving by nines	٣٨— البرهان على صحة العمل باسقاط التسعات
39. Casting out the nines	٣٩— اسقاط التسعات
40. Proving by elevens	٤٠— البرهان على صحة العمل باستعمال العدد ١١
41. The continued product of three or more factors.	٤١— حاصل ضرب ثلاثة عوامل او اكثر
42. Power	٤٢— القوة
43. The second power of a number or the square of a number.	٤٣— القوة الثانية لعدد او مربع العدد
44. The third power of a number or the cube of a number.	٤٤— القوة الثالثة لعدد او مكعب العدد
45. The fourth power of a number The base of the power اساس القوة	٤٥— القوة الرابعة لعدد
46. Index or exponent	٤٦— الاس— اسُّ القوة
47. Involution	٤٧— الرفع الى القوى .
48. Evolution	٤٨— استخراج الجذور
49. Division	٤٩— القسمة
50. Divident	٥٠— المقسوم
51. Divisor	٥١— المقسوم عليه
52. Quotient	٥٢— خارج او ناتج القسمة
53. Remainder	٥٣— باقي القسمة
54. Dividend= Divisor x quotient + Remainder	٥٤— المقسوم= المقسوم عليه× خارج القسمة+ باقي القسمة.
55. The sign of division (÷) or (/)	٥٥— علامة القسمة (÷)او (/)
56. 5÷2 (read 5 divided by 2 or 5 over 2).	٥٦— ٥÷٢ (تقرأ ٥ تقسيم ٢ او ٥ على ٢)
57. Brackets	٥٧— الاقواس
58. > is greater than (Example: 5>3)	٥٨— > اكبر من [مثلا : ٥ > ٣]
59. < is less than (Example: 3<5)	٥٩— < اصغر من [مثلا : ٣ < ٥]
60. Length, area, volume, capacity, time, angle.	٦٠— الطول، المساحة، الحجم، السعة، الزمن، الزاوية.
61. One chain=100 links= 22yards	٦١— السلسلة الواحدة= ١٠٠ حلقة= ٢٢ ياردة
62. One furlong= 10 chains= 220 yrds. = ⅛ of a mile	٦٢— مقياس طولي = $\frac{1}{8}$ ميل= ٢٢٠ يارد .
63. One fathom = 6ft.	٦٣— القامة الواحدة= ٦ اقدام
64. One knot= 6080 ft.= one nautical mile = one geographical mile:(admiralty mile) = the length of one minute of arc or the equation	٦٤— الميل البحرى الواحد = ٦٠٨٠ قدما
65. One mile= 5280 ft.=(1 English or statute mile)	٦٥— الميل الواحد = ٥٢٨٠ قدما
66. One league = 3 nautical miles.	٦٦— الفرسخ الواحد = ٣ اميال.
67. One hand = 4 inches	٦٧— ٤ انجات
68. One pole = 5½ yards	٦٨— القصبة— = ½٥ ياردات
69. A leap year	٦٩— السنة الكبيسة
70. One dozen = 12 units	٧٠— الدزينة=الدرزن = ١٢ وحدة
71. One gross	٧١— الكروس= ١٢ دزينة
72. One score	٧٢— ٢٠ وحدة
73. One quire	٧٣— ٢٤ ورقة
74. One ream= 20 quires = 480 sheets of papers	٧٤— بند ورق= ٤٨٠ ورقة

75. Denomination,	٧٥ـ نوع.
Example: Reduce £5 3s 4d. to the same denomination, the pence: £5 3s 4d.= 5x20x12+3x12+4= 1240 d	حول خمس دنانير و ٣ دراهم و١٥ فلسا الى نوع واحد من العملة، الفلس مثلا : ٥×٢٠٠٠×٢+٥٠٠×٣+٥٠+١٥=٥٠٠٠+١٥٠+١٥=٥١٦٥ فلسا
76. Multiple	٧٦ـ مضاعف.
77. Common factor	٧٧ـ عامل مشترك
78. Consecutive numbers	٧٨ـ اعداد متتالية
79. Even numbers	٧٩ـ اعداد زوجية
80. Odd numbers	٨٠ـ اعداد فردية
81. Prime numbers= primes	٨١ـ اعداد اولية
82. Composite numbers	٨٢ـ اعداد غير اولية
83. Numbers prime to one another (Ex: 4, 13, 25, 49)	٨٣ـ اعداد لا يوجد بينها عامل مشترك سوى الواحد, مثال: ٤، ١٣، ٢٥، ٤٩)
84. Two Complementary numbers (Ex: 25+74=99)	٨٤ـ عددان مجموعها مكون من تسعات (مثلا : (٢٥+٧٤=٩٩).
85. Divisibility by a number (Ex: 39 is divisible by 3)	٨٥ـ قابلية القسمة على عدد (مثلا : ٣٩ قابل القسمة على ٣).
86. Ascending order	٨٦ـ ترتيب تصاعدى = ترتيب متصاعد
87. Descending order	٨٧ـ ترتيب تنازلي = ترتيب متنازل
88. Factoring = resolving into factors	٨٨ـ التحليل الى العوامل
89. Highest common factor (H.C.F.) Greatest common factor (G.C.F.) = Greatest common measure (G.C.M.) = Highest common divisor (H.C.D.)	٨٩ـ العامل المشترك الاعلى العامل المشترك الاعظم القاسم المشترك الاعلى
90. Miscellaneous	٩٠ـ متنوع
91. Least common multiple= lowest common multiple (L.C.M.)	٩١ـ المضاعف المشترك الاصغر المضاعف المشترك الادنى
92. Hint	٩٢ـ اشارة او تلميح الى كيفية الحل
93. An Integer = a whole number	٩٣ـ عدد صحيح
94. The Integral part of the number (3.51) is (3).	٩٤ـ الجزء الصحيح من العدد (٣٫٥١) هو (٣)
95. Fraction	٩٥ـ الكسر
96. Vulgar fraction= common fraction	٩٦ـ الكسر الاعتيادى
97. Decimal fraction	٩٧ـ الكسر العشرى
98. The Numerator of a fraction	٩٨ـ بسط الكسر= صورة الكسر
99. The Denominator of a fraction	٩٩ـ مقام الكسر= مخرج الكسر
100. Proper fraction (ex: $\frac{17}{24}$)	١٠٠ـ كسر حقيقي (مثلا $\frac{١٧}{٢٤}$)
101. Improper fraction (Ex: $\frac{25}{14}$)	١٠١ـ كسر لفظي (مثلا : $\frac{٢٥}{١٤}$)
102. A mixed number (ex: $52\frac{3}{7}$	١٠٢ـ عدد كسرى (مثلا : $\frac{٣}{٧}$ ٥٢)= عدد مختلط
103. Reduction of fractions	١٠٣ـ اختزال الكسور
104. Cancelling the common factors from the numerator & denominator of a fraction.	١٠٤ـ اختصار العوامل المشتركة من بسط كسر ومقامه.
105. The reduction of a fraction to its lowest terms.	١٠٥ـ اختصار الكسر الى ابسط حديه

106. Comparison of fractions	١٠٦ــ مقارنة الكسور
107. The reciprocal of the number 3 is ($\frac{1}{3}$)	١٠٧ــ مقلوب العدد (٣) هو ($\frac{١}{٣}$)
108. A complex fraction (Ex.: $\frac{\frac{2}{7}}{\frac{3}{5}}$)	١٠٨ــ كسر مركب مثلا $\frac{\frac{٢}{٧}}{\frac{٣}{٥}}$
109. Continued fractions Ex.: $\frac{1}{\frac{1}{b+c+\frac{1}{d}}}$	١٠٩ــ الكسور المتسلسلة $\frac{١}{\frac{١}{ب+ جـ + \frac{١}{د}}}$
110. Terminating decimals	١١٠ــ الكسور العشرية المنتهية
111. Recurring decimals (Ex.: $0.\dot{3}$; $0.\dot{4}3\dot{1}$)	١١١ــ الكسور العشرية الدورية (مثلا : ٣ر٠ أو ٤٣١ر٠)
112. Decimal figures	١١٢ــ الارقام العشرية (الارقام يمين الفارزة العشرية)
113. Decimal places	١١٣ــ المراتب العشرية (عدد الارقام يمين الفارزة العشرية)
114. Significant figures (Ex.: in the number 0.00367 the number 3 is the first significant figure after the decimal point).	١١٤ــ الارقام المعنوية (مثلا في العدد ٠٠٣٦٧ر٠ الرقم ٣ هو اول رقم معنوى بعد الفارزة العشرية)
115. A pure circulator (Ex.: $0.\dot{6}$)	١١٥ــ كسر دوري بسيط (مثلا : ٦ر٠)
116. A mixed circulator (Ex.: $0.73\dot{2}\dot{5}$)	١١٦ــ كسر دوري مركب (مثلا ٧٣٢٥ر٠)
117. The generating fraction of a recurring fraction (Ex.: $\frac{1}{3}$ is the generating fraction of $0.\dot{3}$)	١١٧ــ الكسر الاعتيادي المكافيء الى الكسر الدوري . (: $\frac{١}{٣}$ هو الكسر المكافيء للكسر الدوري ٣ر٠)
118. Approximation (Ex.: 0.734=0.73 correct to two decimal places).	١١٨ــ التقريب (مثلا : ٧٣٤ر٠ = ٧٣ر٠ صحيحا الى اقرب مرتبتين عشريتين) .
119. Error	١١٩ــ خطأ .
120. Absolute error	١٢٠ــ الخطأ المطلق = الخطأ الحقيقي .
121. Relative error (Ex.: the relative error is $\frac{1}{50}$).	١٢١ــ الخطأ النسبي (مثلا الخطأ النسبي = $\frac{١}{٥٠}$)
122. Percentage error (Ex.: 2 %).	١٢٢ــ الخطأ المئوي (مثلا : ٢ ٪)
123. The Metric System	١٢٣ــ النظام المتري .
124. Average=mean (Ex.: $7=\frac{5+3+8+12}{4}$)	١٢٤ــ المعدل (مثلا : ٧ = $\frac{٥ + ٣ + ٨ + ١٢}{٤}$)
125. Ratio (Ex.: $\frac{2}{3}$ or 2:3)	١٢٥ــ نسبة (مثلا : $\frac{٢}{٣}$ أو ٢ : ٣)
126. Proportion (Ex.: $\frac{2}{3}=\frac{4}{6}$ or 2:3=4:6)	١٢٦ــ تناسب (مثلا : $\frac{٢}{٣} = \frac{٤}{٦}$ أو ٢ : ٣ = ٤ : ٦)
127. The two terms of a ratio	١٢٧ــ حدّا النسبة .
128. Antecedent	١٢٨ــ مقدم النسبة .
129. Consequent	١٢٩ــ تالي النسبة.
130. The extremes (in a proportion)	١٣٠ــ الطرفان (في التناسب)
131. The means (in a proportion)	١٣١ــ الوسطان (في التناسب)
132. The mean proportional between two numbers	١٣٢ــ الوسط المتناسب بين عددين
133. The third proportional to two numbers	١٣٣ــ الثالث المتناسب لعددين

134. The fourth proportional to three numbers	١٣٤ــ الرابع المتناسب لثلاثة اعداد
135. Direct proportion	١٣٥ــ تناسب طردى
136. Inverse proportion	١٣٦ــ تناسب عكسي
137. Compound proportion	١٣٧ــ تناسب مركب مثلا : رجل يحفر مترا ساعة يوم ٦٤ يحفر ٥٠ ١٢ ٥ ٨٠ " ٧٥ ٨ س
138. Proportional division	١٣٨ــ التقسيم التناسبي
139. Partnership	١٣٩ــ الشركة
140. Percentage	١٤٠ــ النسبة المئوية
141. Profit	١٤١ــ الربح
142. Loss	١٤٢ــ الخسارة
143. Rate	١٤٣ــ السعر (كما في الربح البسيط او المركب مثلا ٣ ٪)
144. Taxes	١٤٤ــ الضرائب
145. Simple interest	١٤٥ــ الربح البسيط
146. Compound interest	١٤٦ــ الربح المركب
147. The principal	١٤٧ــ رأس المال = المبلغ (في الربح [illegible]
148. The amount=the principal+the interest	١٤٨ــ الجملة = رأس المال + الربح
149. Per annum	١٤٩ــ سنويا = بالسنة
150. Discount	١٥٠ــ الخصم = الحسم
151. Nominal value of a draft	١٥١ــ القيمة الاسمية للكمبيالة
152. Present value of a draft	١٥٢ــ القيمة الحالية للكمبيالة
153. Shares	١٥٣ــ حصص
154. Stocks	١٥٤ــ اسهم (قيمة ما يساويه ١٠٠ دينار من اصل رأس المال)
155. Bonds	١٥٥ــ سندات
156. Shareholders	١٥٦ــ المساهمون = حاملو الاسهم
157. Dividend (each shareholder's profit from the total profit)	١٥٧ــ ربح المساهم

158. The term "stock" is applied to the capital of a company, any portion of which, large or small, may be bought or sold.

159. The meaning of the expression "3% stock at 102" is that a company is paying a dividend of 3% on its capital or stock, £100 of which is at the time selling for £102.

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Terms used in Geometry
الاصطلاحات المستعملة في الهندسة

160. Axioms	١٦٠ـــ بديهيات
161. Postulates	١٦١ـــ موضوعات
162. Point	١٦٢ـــ نقطة
163. Straight line (st.)	١٦٣ـــ خط مستقيم
164. Broken line	١٦٤ـــ خط منكسر
165. Curved line	١٦٥ـــ خط منحن
166. A plane surface or a plane	١٦٦ـــ سطح مستوى
167. A solid figure	١٦٧ـــ الشكل المجسم
168. Space	١٦٨ـــ الفراغ
169. Angle	١٦٩ـــ الزاوية
170. The arms of the angle	١٧٠ـــ اضلاع الزاوية
171. The vertex of the angle	١٧١ـــ رأس الزاوية
172. Adjacent angles	١٧٢ـــ زاويتان متجاورتان
173. Vertically opposite angles	١٧٣ـــ الزوايا المتقابلة بالرأس
174. Right angle	١٧٤ـــ الزاوية القائمة
175. Acute angle	١٧٥ـــ الزاوية الحادة
176. Obtuse angle	١٧٦ـــ الزاوية المنفرجة
177. Straight angle	١٧٧ـــ الزاوية المستقيمة
178. Reflex angle	١٧٨ـــ الزاوية المنعكسة
179. A perigon	١٧٩ـــ الزاوية المحيطة = ٤ قوائم (حولية)
180. A vertical line	١٨٠ـــ مستقيم شاقولي (رأسي)
181. A line perpendicular to another line	١٨١ـــ مستقيم عامودى على مستقيم آخر
182. Degree (o)	١٨٢ـــ درجة
183. Minute (')	١٨٣ـــ دقيقة
184. Second (")	١٨٤ـــ ثانية
185. The three dimensions (or magnitudes)	١٨٥ـــ الابعاد الثلاثة
186. Lengths, width or breadth, & thickness	١٨٦ـــ الطول العرض السمك
187. Two angles of the same magnitudes	١٨٧ـــ زاويتان متساويتان بالمقدار
188. A plane figure	١٨٨ـــ شكل مستوى
189. Circle	١٨٩ـــ دائرة
190. Centre	١٩٠ـــ مركز الدائرة
191. Circumference	١٩١ـــ المحيط
192. Radius (plural: Radii)	١٩٢ـــ نصف القطر
193. Diameter	١٩٣ـــ القطر
An arc of a circle	قوس دائرة
194. A chord of a circle	١٩٤ـــ وتر دائرة
195. Semi-circle	١٩٥ـــ نصف دائرة
196. To bisect	١٩٦ـــ ينصّف
197. To trisect	١٩٧ـــ يثلّث
198. The superposition of one figure upon another	١٩٨ـــ تطابيق شكل على شكل آخر انطباقا تاما
199. Two figures are made to coincide with one another	١٩٩ـــ تطابيق شكلين احدهما على الآخر
200. Sector of a circle	٢٠٠ـــ قطاع دائرة
201. Segment of a circle	٢٠١ـــ قطعة دائرة
	[illegible]
	٢٠٢ـــ [illegible]

202. Two congruent figures	٢٠٢ـــ شكلان متطابقان
203. Straight ruler	٢٠٣ـــ مسطرة مستقيمة
204. The compasses (a pair of compasses)	٢٠٤ـــ البركال
205. The protractor	٢٠٥ـــ المنقلة
206. The squares (Set square)	٢٠٦ـــ الكونية
207. Proposition	٢٠٧ـــ قضية هندسية
208. Theorem	٢٠٨ـــ نظرية هندسية
209. Problem	٢٠٩ـــ مسألة (عملية)
210. Corollary	٢١٠ـــ نتيجة
211. Given	٢١١ـــ المفروض
212. Data معاليم ا , unknown quantities المجاهيل	٢١٢ـــ
213. Required to prove	٢١٣ـــ المطلوب اثباته
214. Construction	٢١٤ـــ العمل
215. Proof	٢١٥ـــ البرهان
216. Q.E.D. (Quod erat Demonstrandum)	٢١٦ـــ وهو المطلوب اثباته
217. Complementary angles	٢١٧ـــ زاويتان متتامتان
218. Supplementary angles	٢١٨ـــ زاويتان متكاملتان
219. The perimeter of a figure	٢١٩ـــ محيط شكل ما
220. The area of a figure	٢٢٠ـــ مساحة شكل ما
221. Rectilineal figure	٢٢١ـــ شكل محاط بخطوط مستقيمة
222. Triangle	٢٢٢ـــ مثلث
223. Quadrilateral	٢٢٣ـــ شكل رباعي
224. Polygon	٢٢٤ـــ مضلع
225. An equilateral polygon	٢٢٥ـــ مضلع متساوي الاضلاع
226. An equiangular polygon	٢٢٦ـــ مضلع متساوي الزاويا
227. A regular polygon	٢٢٧ـــ مضلع منتظم
228. An equilateral triangle	٢٢٨ـــ مثلث متساوي الاضلاع
229. An isosceles triangle	٢٢٩ـــ مثلث متساوي الساقين
230. A scalene triangle	٢٣٠ـــ مثلث مختلف الاضلاع
231. The vertex (plural: vertices) of a triangle	٢٣١ـــ رأس المثلث جمعها رؤوس
232. ----------------The base of a triangle	٢٣٢ـــ قاعدة المثلث
233. The height or altitude of a triangle	٢٣٣ـــ ارتفاع المثلث
234. The vertical angle of an isosceles triangle	٢٣٤ـــ زاوية الرأس في مثلث متساوي الساقين
235. The base angles of an isosceles triangle	٢٣٥ـــ زاويتا القاعدة في مثلث متساوي الساقين
236. A right-angled triangle	٢٣٦ـــ مثلث قائم الزاوية
237. An obtuse-angled triangle	٢٣٧ـــ مثلث منفرج الزاوية
238. An acute-angled triangle	٢٣٨ـــ مثلث حاد الزوايا
239. A convex polygon	٢٣٩ـــ مضلع محدب
240. A concave	٢٤٠ـــ مضلع مقعر
241. An oblique triangle	٢٤١ـــ مثلث غير قائم (حاد الزاوية او منفرج الزاوية)
242. Hypotenuse	٢٤٢ـــ وتر المثلث القائم الزاوية
243. Median	٢٤٣ـــ المستقيم المتوسط في المثلث
244. The internal angles of a polygon	٢٤٤ـــ الزوايا الداخلية للمضلع
245. The external angles of a polygon	٢٤٥ـــ الزوايا الخارجية للمضلع
246. The side opposite to an angle	٢٤٦ـــ الضلع المقابل الى زاوية ما

247. The six parts of a triangle	٢٤٧ـ اجزاء المثلث الست
248. The sides of a polygon	٢٤٨ـ اضلاع المضلـــــع
249. The perpendicular bisector of a line.	٢٤٩ـ العمود المنصف لمستقيم ما
250. The foot of the perpendicular	٢٥٠= موقع العمود
251. The diagonal of a polygon	٢٥١ـ قطر المضلع
252. Parallel st.lines	٢٥٢ـ مستقيمات متوازية
253. Intersecting st.lines	٢٥٣ـ مستقيمات متقاطعة
254. Concurrent " "	٢٥٤ـ مستقيمات متلاقية في نقطة واحدة
255. A transversal	٢٥٥ـ قاطع
256. Alternate angles	٢٥٦ـ زوايا متبادلة
257. Corresponding angles (exterior interior angles on the same side of the transversal)	٢٥٧ـ زوايا متناظرة
258. Two sides & the included angle	٢٥٨ـ ضلعان والزاوية المحصورة
259. A parallelogram	٢٥٩ـ متوازى الاضلاع
260. A rectangle	٢٦٠ـ المستطيل
261. A square	٢٦١ـ المربع
262. A rhombus	٢٦٢ـ المعين
263. A trapezium or a trapezoid	٢٦٣ـ شبه منحرف
264. The intercepts of a transversal between a set of parallel lines	٢٦٤ـ الاجزاء المحصورة من مستقيم قاطع لمجموعة مستقيمات متوازية
265. Projection (or thogonal = = right-angled).	٢٦٥ـ مسقط (عمودى=قائم الزاوية)
266. To describe a circle=to draw=to contruct	٢٦٦ـ رسم دائرة
267. To produce a st.line (or to extend)	٢٦٧ـ تمديد المستقيم
268. Diagonal scale	٢٦٨ـ مقياس الرسم القطرى
269. Decimal diagonal scale	٢٦٩ـ مقياس الرسم القطرى لقياس الاعشار
270. The ambiguous case	٢٧٠ـ الحالة المبهمة
271. Locus (pl. loci)	٢٧١ـ المحل الهندسي
272. To plot the locus	٢٧٢ـ رسم المحل الهندسي
273. Concurrent lines	٢٧٣ـ مستقيمات متلاقية في نقطة واحدة
274. The centriod of the triangle	٢٧٤ـ محل التقاء الخطوط المتوسطة في المثلث
275. Rectangular axes (singular, axis)	٢٧٥ـ المحوران الاحداثيان المتعامدان
276. Coordinates	٢٧٦ـ الاحداثيات (الابعاد الاحداثية)
277. Abscissa	٢٧٧ـ احداثي افقي (يقاس على محور السينات)
278. Ordinate	٢٧٨ـ احداثي رأسي (يقاس على محور الصادات)
279. The x-axis (the horizontal axis)	٢٧٩ـ محور السينات
280. The y-axis (the vertical axis)	٢٨٠ـ محور الصادات
281. The origin	٢٨١ـ نقطة الاصل
282. The four quadrants	٢٨٢ـ الارباع الاربعة
283. Concentric circles	٢٨٣ـ دوائر متحدة المركز
284. Major & minor arcs in a circle	٢٨٤ـ القوس الاكبر والاصغر في دائرة
285. Symmetrical about a line	٢٨٥ـ التماثل حول مستقيم (متماثل الوضع بالنسبة لمستقيم
286. Axis of Symmetry	٢٨٦ـ محور التماثل
287. The line of centres of two circles	٢٨٧ـ خط المركزين لدائرتين

288. A circle circumscribed about a triangle	٢٨٨— دائرة مرسومة حول مثلث
289. Circum-circle	٢٨٩— دائرة خارجية
290. Circum-centre & circum radius	٢٩٠— مركز الدائرة الخارجية ونصف قطر الدائرة الخارجية
291. Concyclic points	٢٩١— نقاط دائرية تقع على محيط دائرة واحدة
292. A circle inscribed in a triangle	٢٩٢— دائرة مرسومة داخل مثلث
293. The inscribed circle	٢٩٣— الدائرة الداخلية
294. A cyclic quadrilateral	٢٩٤— شكل رباعي دائري (يمكن امرار دائرة من رؤوسه)
295. Tangent to a circle	٢٩٥— مماس الدائرة
296. A secant of a circle	٢٩٦— قاطع الدائرة
297. The point of contact	٢٩٧— نقطة التماس
298. Circles touching each other internally or externally.	٢٩٨— دائرتان متماستان من الداخل والخارج
299. Geometrical analysis	٢٩٩— التحليل الهندسي (الطريقة التحليلية في حل المسائل)
300. Direct common tangent to two circles	٣٠٠— المماس المشترك بين دائرتين (خارجي)
301. Transverse " " " " "	٣٠١— " " " " (داخلي)
302. Pentagon	٣٠٢— المخمس
303. Hexagon	٣٠٣— المسدس
304. Heptagon	٣٠٤— المسبع
305. Octagon	٣٠٥— المثمن
306. Nonagon	٣٠٦— المتسع
307. Decagon	٣٠٧— المعشر
308. Dodecagon	٣٠٨— ذو الاحد عشر ضلعا
309. Quindecagon	٣٠٩— ذو الخمسة عشر ضلعا
310. An escribed circle of a triangle	٣١٠— دائرة التماس الخارجية (الدائرة التي تمس احد اضلاع المثلث وامتداد الضلعين الآخرين)
311. The ex-centres of a triangle	٣١١— مركز الدائرة المماسة كل منها الى ضلع واحد وامتداد ضلعين اخرين
312. The orthocentre of a triangle	٣١٢— نقطة تلاقي الاعمدة المنزلة من رؤوس المثلث على الاضلاع المقابلة
313. The pedal or orthocentric triangle	٣١٣— المثلث الحاصل من وصل مواقع الاعمدة النازلة من رؤوس المثلث على الاضلاع المقابلة
314. A line divided in medial section	٣١٤— تقسيم مستقيم قسمة ذات وسط وطرفين
315. Internally or externally	٣١٥— تقسيم مستقيم من الداخل ومن الخارج بنفس النسبة
316. A line-segment cut harmonically	٣١٦— تقسيم مستقيم قسمة توافقية
317. Similar figures	٣١٧— اشكال متشابهة
318. Solid Geometry	٣١٨— الهندسة المجسمة
319. Co-planer st.line	٣١٩— مستقيمات واقعة في مستو واحد
320. Skew lines	٣٢٠— مستقيمان ليسا في مستو واحد – مستقيمان متخالفان
321. A line oblique to a plane	٣٢١— مستقيم مائل بالنسبة لمستوى (غير عمودي)
322. Dihedral angle	٣٢٢— زاوية زوجية
323. Solid angle	٣٢٣— زاوية مجسمة
324. The vertex of a solid angle	٣٢٤— رأس الزاوية المجسمة
325. The edges & the face angles of a solid angle.	٣٢٥— الاحرف والزوايا الوجهية للزاوية المجسمة
326. The plane angle of a dihedral	٣٢٦— الزاوية المستوية للزاوية الزوجية
327. A trihedral angle	٣٢٧— زاوية مجسمة ثلاثية

328. A polyhedral angle	٣٢٨ــ زاوية كثيرة الاوجه
329. A polyhedron	٣٢٩ــ جسم كثير الوجوه
330. A parallelopiped	٣٣٠ــ متوازى السطوح
331. A cuboid or a rectangular solid	٣٣١ــ متوازى المستطيلات
332. The prism	٣٣٢ــ منشور
333. The base, or ends of a prism	٣٣٣ــ قاعدتا المنشور
334. The lateral or side-faces of a prism	٣٣٤ــ الاوجه الجانبية للمنشور
335. Right or obblique prism	٣٣٥ــ منشور قائم او مائل
336. The pyramid	٣٣٦ــ الهرم
337. The lateral & total surface of a pyramid	٣٣٧ــ المساحة الجانبية والكلية للهرم
338. A tetrahedron	٣٣٨ــ جسم ذو اربعة وجوه ثلاثية
339. The height of a pyramid	٣٣٩ــ ارتفاع الهــــــرم
340. The slant height of a regular pyramid	٣٤٠ــ الارتفاع الجانبي للهرم
341. The regular polyhedra	٣٤١ــ الاجسام المنتظمة
342. A truncated pyramid	٣٤٢ــ هرم مقطوع
343. A frustum of a pyramid	٣٤٣ــ هرم ناقص
344. A right circular cylinder	٣٤٤ــ الاسطوانة الدائرية القائمة
345. The cylindric surface	٣٤٥ــ السطح الاسطواني
346. The generatrix of a cylindric surface	٣٤٦ــ المستقيم الذى يولد السطح الاسطواني
347. The element of a cylinder	٣٤٧ــ الراسم او المولد
348. The directrix or the guide	٣٤٨ــ الدليل او المنحني الثابت
349. The right circular cone	٣٤٩ــ المخروط الدائرى القائم
350. The prismoid	٣٥٠ــ شبه المنشور
351. The section of a polyhedron	٣٥١ــ مقطع كثير السطوح
352. The conic sections	٣٥٢ــ القطاعات المخروطة
353. The sphere	٣٥٣ــ الكرة
354. A great & asmall circle	٣٥٤ــ الدائرة العظيمة والدائرة الصغيرة
355. Spherical distance between two points on a sphere	٣٥٥ــ البعد الكروى بين نقطتين على سطح كرة
356. The pole of a circle on a sphere	٣٥٦ــ قطب الدائرة المرسومة على الكرة
357. The polar distance	٣٥٧ــ البعد القطبي لدائرة مرسومة على الكرة
358. The spherical angle	٣٥٨ــ الزاوية الكروية
359. A quadrant	٣٥٩ - الربع (لدائرة عظيمة)
360. The spherical polygon	٣٦٠ــ المضلع الكروى
361. The spherical triangle	٣٦١ــ المثلث الكروي
362. Polar triangles	٣٦٢ــ المثلثات القطبية
363. A bi-rectangular triangle	٣٦٣ــ مثلث قائم الزاويتين
364. A tri-rectangular triangle	٣٦٤ــ مثلث قائم الزوايا
365. Symmetric spherical triangles	٣٦٥ــ مثلثات كروية متماثلة
366. Spherical degree	٣٦٦ــ الدرجة الكروية
367. The lune	٣٦٧ــ الهلال
368. The spherical excess	٣٦٨ــ الفضلة الكروية
369. The Zone	٣٦٩ــ المنطقة
370. A zone of one base	٣٧٠ــ منطقة ذات قاعدة واحدة
371. A spherical segment or a frustum of a sphere	٣٧١ــ القطعة الكروية
372. The cap of a segment of one tase	٣٧٢ــ سطح المنطقة ذات القاعدة الواحدة
373. The spherical sector	٣٧٣ــ القطاع الكروى
374. The spherical pyramid	٣٧٤ــ الهرم الكروى
375. The spherical wedge.	٣٧٥ــ الاسفين الكروى

Terms used in Algebra

377. Terms	٣٧٧ـ الحدود الجبرية
378. An Algebric Expression	٣٧٨ـ مقدار جبرى
379. Simple Expressions	٣٧٩ـ مقادير جبرية بسيطة (ذات حد واحد)
380. Compound Expressions	٣٨٠ـ مقادير جبرية مركبة (مكونة من اكثر من حد واحد)
381. Monomial, Binomial, Trinomial, Multinomial	٣٨١ـ ذو الحد الواحد ،ذو الحدين ،ذو ثلاثة حدود . كثير الحدود
382. Coefficient	٣٨٢ـ معامل
383. Literal coefficient	٣٨٣ـ معامل حرفي
384. Power	٣٨٤ـ قوة
385. Index (pl-indices) or exponents	٣٨٥ـ الاس
386. The base of the power	٣٨٦ـ اساس القوة
387. Second or third power etc..	٣٨٧ـ الدرجة الثانية والثالثة للقوة الخ ، القوة الثانية او الثالثة
388. Square root	٣٨٨ـ الجذر التربيعي
389. Cube root	٣٨٩ـ الجذر التكعيبي
390. Fourth root	٣٩٠ـ الجذر الرابع
391. Positive & negative terms	٣٩١ـ الحدود الموجبة والسالبة
392. Like and unlike terms	٣٩٢ـ الحدود المتشابهة والغير متشابهة
393. Transposing & collecting like terms	٣٩٣ـ نقل الحدود وجمع الحدود المتشابهة منها
394. Algebraic sum	٣٩٤ـ حاصل الجمع الجبرى
395. The dimension or the degree of a term	٣٩٥ـ درجة الحد
396. The degree of an algebraic expression	٣٩٦ـ درجة المقدار الجبرى
397. A homogeneous "	٣٩٧ـ مقدار جبرى متجانس(جميع حدوده من درجة واحدة)"
398. To solve a problem by inspection	٣٩٨ـ حل السؤال ذهنيا بمجرد النظر اليه
399. To remove brackets	٣٩٩ـ ازالة الاقواس
400. To insert a quantity within two brackets	٤٠٠ـ ادخال كمية بين قوسين
401. Equation	٤٠١ـ معادلة
402. Identity	٤٠٢ـ متطابقة
403. Sides or members of an equation	٤٠٣ـ طرفا المعادلة
404. To satisfy the equation	٤٠٤ـ يحقق المعادلة
405. To verify the solution of an equation	٤٠٥ـ يحقق صحة المعادلة
406. The root or the solution of the equation	٤٠٦ـ جذر المعادلة اوناتج حل المعادلة
407. Linear equation	٤٠٧ـ معادلة من الدرجة الاولى
408. Quadratic equation	٤٠٨ـ = = = الثانية
409. Cubical equation	٤٠٩ـ = = = الثالثة
410. An equation of the fourth degree	٤١٠ـ = = = الرابعة
411. To transpose	٤١١ـ ينقل الحدود من طرف الى طرف للمعادلة
412. Formula (pl. formulas or formulae)	٤١٢ـ قانون ـ دستور
413. The quadratic formula	٤١٣ـ دستور حل المعادلة من الدرجة الثانية
414. An equation in one unknown	٤١٤ـ معادلة ذات مجهول واحد
415. An equation in two unknowns	٤١٥ـ = = مجهولين
416. Simultaneous equations	٤١٦ـ معادلات آنية
417. Solution by elimination	٤١٧ـ حل المعادلة بطريقة الحذف
418. Solution by substitution	٤١٨ـ = = = التعويض
419. Literal equations	٤١٩ـ المعادلات الحرفية

420.	A pure quadratic	٤٢٠— معادلة من الدرجة الثانية (ناقصة)
421.	An affected or an adfected quadratic	٤٢١— = = = = (كاملة)
422.	To make or to complete into a perfect square	٤٢٢— اكمال المربع
423.	The remainder theorem	٤٢٣— نظرية الباقي
424.	The factor theorem	٤٢٤— = العوامل
425.	A surd or an irrational quantity	٤٢٥— جذر اصم او كمية غير نسبية
426.	Rational quantity	٤٢٦— كمية نسبية
427.	The order of the surd	٤٢٧— درجة الجذر الاصم
428.	Quadratic surds	٤٢٨— جذور صماء من الدرجة الثانية
429.	Entire surd	٤٢٩— جذر اصم محض
430.	A surd reduced to its simplest form	٤٣٠— جذر اصم مختصر الى ابسط صورة
431.	Like & unlike surds	٤٣١— جذور صماء متشابهة وغير متشابهة
432.	To rationalise the denomenator	٤٣٢— جعل المقام كمية نسبية او تنسيب المقام
433.	Simple surds	٤٣٣— جذور صماء بسيطة (مكونة من حد واحد)
434.	Compound surds	٤٣٤— = = مركبة (= = اكثر من حد واحد)
435.	Conjugate binomial quadratic surds	٤٣٥— جذران اصمان تربيعيان مترافقان
436.	Abstract quantity (e.g. ratios)	٤٣٦— كمية غير مميزة
437.	Commensurable quantities	٤٣٧— كميات مقيسة معا
438.	Incommensurable quantities	٤٣٨— كميات غير مقيسة معا
439.	The duplicate ratio of a:b	٤٣٩— النسبة التربيعية لـ ا : ب
440.	The triplicate ratio of a:b	٤٤٠— النسبة التكعيبيـــــــة لـ ا : ب
441.	The subduplicate ratio of a:b	٤٤١— النسبة الجذرية التربيعيـــــة لـ ا : ب
442.	A ratio of greater inequality	٤٤٢— نسبة التباين الكبرى
443.	" " " less "	٤٤٣— = = الصغرى
444.	" " " equality	٤٤٤— = المساواة
445.	Continued proportion	٤٤٥— تناسب متسلسل
446.	Variation	٤٤٦— التغير
447.	Direct variation	٤٤٧— التغير الطردي
448.	Inverse variation	٤٤٨— التغير العكسي
449.	To vary inversely	٤٤٩— يتغير تغيرا عكسيا
450.	" " jointly	٤٥٠— = = مشتركا
451.	Series or progressions	٤٥١— المتواليات
452.	Arithmetical progression	٤٥٢— المتواليات الحسابية (العددية)
453.	Geometrical progressions	٤٥٣— المتواليات الهندسية
454.	The common difference of an arith.progr.	٤٥٤— اساس المتوالية العددية
455.	The first term " " " "	٤٥٥— الحد الاول للمتوالية العددية
456.	The n^{th} term or the last term " "	٤٥٦— الحد النوني او الاخير = =
457.	The sum of the terms of the progression	٤٥٧— مجموع حدود المتوالية
458.	Arithmetic mean	٤٥٨— الوسط الحسابي
459.	The common ratio of a geometrcal progression	٤٥٩— اساس المتوالية الهندسية
460.	Geometric mean	٤٦٠— الوسط الهندسي
461.	An increasing or a decreasing progression	٤٦١— متوالية تصاعدية او تنازلية
462.	An infinite series	٤٦٢— متوالية لا نهائية
463.	Harmonical progression	٤٦٣— متوالية توافقية
464.	A real number	٤٦٤— عدد حقيقي
465.	An imaginary number	٤٦٥— عدد تخيلي

466. Discriminant	٤٦٦— المقدار المميز
467. Permutations	٤٦٧— التباديل
468. Combinations	٤٦٨— التوافيق
469. The binomial theorem	٤٦٩— نظرية ذى الحدين
470. Factorial 7! = $\underline{7\rvert}$	٤٧٠— عاملي ٧! = $\underline{٧\rvert}$
471. The expansion of $(a+b)^n$	٤٧١— مفكوك المقدار (ا + ب)^{ن}
472. The general term in the expansion of a binomial	٤٧٢— الحد العام في مفكوك ذى الحدين
473. Logarithms	٤٧٣— اللوغاريثمات
474. Common logarithms	٤٧٤— اللوغاريثمات المعتادة
475. Natural logarithms	٤٧٥— = الطبيعية
476. The characteristic of a log	٤٧٦— العدد البياني للوغاريثم
477. The mantissa of a log (pl. mantissae)	٤٧٧— الجزء العشرى =
478. Augmented logarithms	٤٧٨— اللوغاريثم الجدولي
479. The four-figure table	٤٧٩— الجداول ذات الاربع مراتب العشرية
480. The difference columns	٤٨٠— اعمدة الفروق
481. Interpolation	٤٨١— عملية حساب الفروق
482. The antilogarithm	٤٨٢— العدد المقابل للوغاريثم
483. Scales of notation	٤٨٣— موازين عدية
484. The common or denary scale of notation	٤٨٤— الطريقة العادية او الميزان العشرى للعدية
485. The radix of the scale	٤٨٥— أساس الميزان
486. Radix fractions	٤٨٦— كسور اساسية (كسور ذات اساس غير الـ ١٠)
487. Radix point	٤٨٧— الفارزة الاساسية (مناظرة للفارزة العشرية)
488. Exponentional series	٤٨٨— المتواليات الاسية
489. Annuity	٤٨٩— دفعة سنوية
490. The amount of an annuity	٤٩٠— جملة الدفعة السنوية
491. The present value of an annuity	٤٩١— القيمة الحالية للدفعة السنوية
492. The number of year's purchase of an annuity	٤٩٢— عدد الاقساط السنوية للدفعة
493. A free hold estate	٤٩٣— عقار حـــــــر
494. A constant	٤٩٤— مقدار ثابت
495. A variable	٤٩٥— = متغير
496. An absolute constant	٤٩٦— مقدار ثابت مطلقا
497. An arbitrary "	٤٩٧— مقدار ثابت اصطلاحا
498. A function	٤٩٨— دالة
499. The independent variable	٤٩٩— المتغير الاصلي
500. The dependent "	٥٠٠— = التابع
501. Graphs	٥٠١— الاشكال البيانية
502. Bar graphs	٥٠٢— اشكال المستطيلات البيانية
503. Broken-line graphs	٥٠٣— = الخطوط المنكسرة البيانية
504. Circle "	٥٠٤— الدائرة البيانية
505. Curve-line "	٥٠٥— الخطوط المنحنية البيانية
506. Squared paper (cross sectioned)	٥٠٦— الورق المقسم الى مربعات
507. Graph of a function	٥٠٧— الشكل البياني للدالة
508. A linear function of (x)	٥٠٨— دالة (س) من الدرجة الاولى
509. A quadratic " " "	٥٠٩— = = = الثانية
510. The parabola	٥١٠— القطع المكافئ

511. The ellipse	٥١١ـ القطع الناقص
512. The hyperbola	٥١٢ـ = الزائد
513. Maximum & Minimum values	٥١٣ـ قيم النهايات العظمى والصغرى
514. Infinity	٥١٤ـ اللانهاية
515. Asymptotes	٥١٥ـ الخطوط المحاذية
516. Rectangular hyperbola	٥١٦ـ القطع الزائد القائم

Terms used in trigonometry

517. Trigonometry	٥١٧ـ حساب المثلثات
518. The trigonometric ratios or functions	٥١٨ـ النسب المثلثية
519. The generation of an angle	٥١٩ـ توليد الزاوية
520. The initial side & the terminal side of an angle	٥٢٠ـ ضلع الزاوية الثابت والضلع النهائي
521. Clockwise rotation	٥٢١ـ دوران باتجاه عقارب الساعة
522. Counterclockwise rotation or anticlockwise rotation	٥٢٢ـ = = مضاد لدوران عقارب الساعة
523. The first, second, third & fourth quadrants	٥٢٣ـ الربع الاول والثاني والثالث والرابع
524. To rotate or to revolve	٥٢٤ـ يدور
525. Sine ($\sin\theta$)	٥٢٥ـ الجيب = جا هـ
526. Cosine ($\cos\theta$)	٥٢٦ـ جيب التمام = جتا هـ
527. Tangent ($\tan\theta$)	٥٢٧ـ الظل = ظا هـ
528. Cotangent ($\cot\theta$)	٥٢٨ـ ظل التمام = ظتا هـ
529. Secant ($\sec\theta$)	٥٢٩ـ القاطع = قا هـ
530. Cosecant ($\cos\theta$)	٥٣٠ـ قاطع التمام = قتا هـ
531. Tables of natural functions	٥٣١ـ جداول النسب المثلثية
532. Solution of the right triangle	٥٣٢ـ حل المثلث القائم الزاوية
533. " " " oblique "	٥٣٣ـ = = المائل الزوايا
534. The law of sines	٥٣٤ـ قانون الجيوب
535. The law of cosines	٥٣٥ـ قانون جيوب التمام (او قانون التربيع)
536. The law of tangents	٥٣٦ـ قانون الظلال
537. Horizontal & vertical Components	٥٣٧ـ المركبات الافقية والرأسية
538. The resultant force	٥٣٨ـ المحصلة (للقوة)
539. Inaccessible distances	٥٣٩ـ مسافات لا يمكن الوصول اليها
540. Trigonometric equations	٥٤٠ـ معادلات مثلثية
541. " identities	٥٤١ـ متطابقات
542. Relations between the functions of an angle	٥٤٢ـ العلاقة بين النسبة المثلثية للزاوية
543. Circular measure of an angle	٥٤٣ـ التقدير الدائرى للزاوية
544. A radian	٥٤٤ـ زاوية نصف قطرية
545. A vector	٥٤٥ـ خط ذو طول معين وجهة معينة
546. The directed line	٥٤٦ـ الخط الاتجاهي
Simple harmonic motion	٥٤٧ـ الحركة التوافقية البســــيطة.

SIGNIFICANT DIGITS

Significant digits of any number are the reliable or necessary digits - digits which tell the dgree of accuracy of our measurement or estimate, and which must be retained when we change our decimal system of units.

Any number is formed out of one or more of the following digits:

0 1 2 3 4 5 6 7 8 9

The digits 1 through to 9 in any number are always significant but the digit zero is not always so. The following cases must be carefully studied.

(1) The zeros to the left of approximate numbers are always insignificant They are there, simply because of the particular unit of measurement we have chosen; consequently they are not important in that they do not add to the degree of accuracy of our measurement and can be easily dispensed with by a suitable change of units. For example:

75, 0.75, 0.00075

The zeros in the last two numbers are insignificant. Let us suppose that75 represents the distance between two points in cms.; then 0.75 represents the same distance in metres and 0.00075 in kms. In each of the 3 cases the degree of accuracy of our measurement (i.e. 2 significant figures) has not changed, the zeros have been added to the left of the number because we changed our decimal system of units from cms. to meters and then to kms.

(2) Zeros in between two significant digits of a number are always significant.

These zeros are an integral part of the number and cannot be omitted by any decimal change of units; e.g. the distance between two points to three significant digits is 309 metres; change the units to km, the distance becomes 0.309 kms. The zero is still there, change to cms, and the middle 0 is still there.

(3) Zeros at the right of a whole number may or may not be significant. With experience and common sense, the student will be in a position to tell which is which. THe following hints, however, are helpful:

(i) If the number is the result of counting, the zeros are significant.i.e. the annual salary of the U.S. President is $150.000 or the annual allowances of the British Queen is £500.000. The zeros in these two numbers are significant.

(ii)If the number indicates a measurement or an estimate, the zeros at the end are insignificant e.g. the distance of the moon to the earth is 233,000 miles; it is obvious that this is not an exact number, we have simply rounded off our measurement to the nearest 1000miles. This number is correct to 3 significant figures only.

Again when we say the estimated profit of a business man during the year to come is £7500, this figure cannot be exact as we have simply estimated the profit to the nearest £100; the zeros are, therefore, insignificant and the number is said to be correct to 2 significant digits.

(4)Zeros to the right of the decimal point are always significant; they are important, otherwise there would not be a point in putting them there, e.g. 27.00m. means that we have carried out our measurement accurately to the nearest cm; this figure is, therefore, correct to 4significant digits. On the other hand 27 is correct to two significant digits.

(١٠) أحرق ٠٫٧٦ غم من غبار الكاربون بتيار من الاوكسجين وأمرر ثاني أوكسيد الكاربون الناتج على منتفخ يحتوى على هيدروكسيد البوتاسيوم فاذا كان وزن المنتفخ والهيدروكسيد قبل وبعد امرار الغاز ٥٢٫٠٨ غم و ٥٤٫٨٤ غم احسب مكافيء الكاربون .

(١١) نموذج من القارصين يحتوى كمية من أوكسيده. ٠٫٨ غم من هذا النموذج اذيبت في حامض مررت ٢١٥ سم٣ من الهيدروجين الجاف في درجة ١٧م٥ وضغط ٧٧٠ ملم/زئبق احسب النسبة المئوية لاوكسيد القارصين في النموذج علما بان مكافيء القارصين ٣٢٫٥ غم .

" الأوزان الذرية "

الوزن الذرى التقريبي × الحرارة النوعية = ٦٫٤

$\frac{\text{الوزن الذرى التقريبي}}{\text{الوزن المكافيء}}$ = التكافوء "وهو عدد صحيح"

الوزن الذرى المضبوط = الوزن المكافيء × التكافوء .

(١) اذا كانت الحرارة النوعية للبلاتين والماس ، المغنيسيوم وسائل الاوكسجين هي على التوالي ٠٫٠٣٢ ، ٠٫١١٣ ، ٠٫٢٤ ، ٠٫٣٤٧ فهل تؤيد هذه الارقام قانون دولونك وبتي اذا كانت اوزانها الذريه ١٩٥٫٢ ، ١٢ ، ٢٤٫٣٢ ، ١٦٫٠

(٢) ما الحرارة النوعية التقريبية لفلز وزنه الذرى المضبوط ٢١١ ؟

(٣) اذا كانت الحرارة النوعية لفلز ٠٫٠٦٣ ، ٣٫٢٥ غم من هذا الفلز اعطى عند اكسدته ٤٫٠٥ غم من الاوكسيد فما هو الوزن الذرى المضبوط لهذا الفلز.

(٤) عند تسخين ١٫٦٨ غم من برادة فلز الى وزن ثابت وفي تيار مستمر من الاوكسجين حصلنا على ٢٫٤٠ غم من اوكسيد الفلز. فما الوزن المكافيء للفلز واذا علمت ان الحرارة النوعية له ٠٫١١ فما الوزن الذرى المضبوط له .

(٥) ٠٫٢٠ غم من فلز عند اذابته في حامض الهيدروكلوريك اعطى ١٦٦ سم٣ من الهيدروجين الذي قيس وهو جاف في ظ.ق. فاذا كانت الحرارة النوعية للفلز ٠٫٢٢ فما المكافيء ، الوزن الذرى التقريبي ، التكافوء. ثم اضبط الوزن الذري للفلز .

كمبيا رقم ٥٦

٦– ملح مائي يحتوي ١٤ر٢٦ ٪ من الصوديوم ، ٩ر٩٤ ٪ من الكبريت ، ١٩ر٨٧ ٪ من الاوكسجين ٥٥ر٩ ٪ من الماء احسب الصيغة الوضعية للملح .

٧– ملح يحتوي ١٤ر٣١ ٪ من الصوديوم ، ٩ر٩٧ ٪ من الكبريت ، ٦ر٢٥ ٪ من الهيدروجين و ٦٩ر٤٧ ٪ من الاوكسجين احسب صيغته اذا علمت ان جميع الهيدروجين متحدا بالاوكسجين مكونا ماء التبلور .

٨– بلورات من كبريتات الخارصين يحتوي على ٤٣ر٩ ٪ من ماء التبلور احسب عدد جزيئات ماء التبلور المرتبط بجزيئة واحدة من الملح .

٩– عند سحب ~~ع~~ ماء التبلور من ٢ر٥٦ غم من صودا الغسيل تبقى ٠ر٩٥ غم من كاربونات الصوديوم احسب عدد جزيئات ماء التبلور المرتبطة بجزيئة من الملح .

١٠– ما الصيغة الجزيئية لكلوريد الزئبقوز اذا كان وزنه الجزيئي ٤٧٢ر١٤ وصيغته الوضعية Hg cl علما ان الوزن الذري للزئبق ٢٠٠ر٦ وللكلور ٣٥ر٥

١١– مركب يحتوي العناصر التالية كاربون ، هيدروجين ، اوكسجين . ~~سخن~~ سخن هذا المركب في جو من الاوكسجين وقد امتص الماء بواسطة كلوريد الكالسيوم وامتص ثاني اوكسيد الكاربون بواسطة البوتاسه الكاوية . فوجد ان ٠ر٤٥ غم من المادة اعطت ٠ر٨٦ غم من ثاني اوكسيد الكاربون و ٠ر٥٣ غم من الماء اوجد الصيغة الوضعية لهذا المركب .

١٢– مركب متطاير يتكون من الهيدروجين والكاربون وقد وجد ان الكاربون يشكل ٩٢ر٣١ ٪ وان الهيدروجين يكون ٧ر٦٩ ٪ فاذا كانت الكثافة النسبية للمركب ٣٩ احسب الصيغة الجزيئية .

١٣– عند التحليل الكمي لـ ١٠ غم من مادة وجد انها تحتوي على ٣ر٧٨ غم من الكاربون و ٠ر٦٣ غم من الهيدروجين و ٥ر٥٩ غم من غاز الكلور وقد وجد ان ٢ر٥٦ غم من هذا المركب يشغل حجما قدره ٦٢٤ سم^3 عند تحويله الى الحالة الغازية وذلك في درجة ١٠٠ م وضغط ٨٧٥ ملم / زئبق . ما الصيغة الجزيئية لهذا المركب .

١٤– كلوريد فلز مثل M اعطى النواتج التالية عند تحليله ٣٤ر٤٦ ٪ من الفلز و ٦٥ر٥٤ ٪ من الكلور وكانت الكثافة النسبية له ٨١ر٢ والحرارة النوعية للفلز ٠ر١١٤ احسب من ذلك الوزن الذري المضبوط للفلز وما الصيغة الجزيئية لهذا الكلوريد .

١٥– مادة هيدروكاربونية تتكون من ٨٢ر٧٦ ٪ من الكاربون و ١٧ر٤٣ ٪ من الهيدروجين ويزن اللتر الواحد منها في درجة ٣٠ م وضغط ٧٥٠ ملم / زئبق ٢ر٣٠٨ غم احسب الصيغة الجزيئية لهذه المادة .

الحسابات الكيمياوية

١– ما وزن كاربونات الكالسيوم التي عند تسخينها التام تعطي ٢١ غم من الكلس الحي .

٢– اذيب عشرة غرامات من اوكسيد الكالسيوم في الماء . ما وزن كاربونات الكالسيوم الناتجة من امرار كفاية من ثاني اوكسيد الكابون عليه .

كمياء رقم ٨

(٣) ما حجم النيتروجين الجاف في ١٢ م° وضغط ٧٧٠ ملم/زئبق الناتج من تسخين ٢ر٣ غم من نترات الامونيوم .

(٤) اوكسيد الرصاص الاحمر Pb_3O_4 عند اتحاده مع حامض النتريك لاعطاء نترات الرصاص وثاني اوكسيد الرصاص PbO_2 . ما وزن فوق اوكسيد الرصاص الناتج من تفاعل ١٣٧ غم من الاوكسيد الاحمر .

(٥) اذيب وزن معين من الفضه في حامض النتريك ثم رسبت الفضه على هيئة كلوريد الفضة باضافة ملح الطعام . فاذا كان ٤٢٢ر١ غم من كلوريد الفضه قد ترسب ، فما مقدار وزن الفضه في النموذج .

(٦) ما وزن كلوريد الفضة المترسب من اضافة لتر واحد من محلول ١٠٪ من ملح الطعام الى محلول نترات الفضه .

(٧) عومل ٥٠ سم٣ من حامض الكبريتيك مع محلول كلوريد الباريوم الساخن حتى اتمام الترسيب وبعد غسل الراسب وتجفيفه وجد انه يزن ١٦٥ر١ غم. احسب تركيز الحامض في هذا المحلول .

(٨) اذيب ٢ غم من ملح كلوبر $Na_2SO_4 \cdot 10H_2O$ في الماء ثم رسب باضافة كمية وافية من كلوريد الباريوم. احسب وزن كبريتات الباريوم المترسبة .

(٩) احسب وزن اوكسيد الزئبق الاحمر الذى يعطي من الاوكسجين ما تعطيه ٥ غرامات من كلورات البوتاسيوم .

(١٠) ما مقدار وزن غاز الكلور بالغرامات التي يمكن الحصول عليها من تسخين ٥٠ غم من ثاني اوكسيد المنغنيز مع كفاية من حامض الهيدروكلوريك .

(١١) اذا اردت تحضير ١٠٠ غم من نترات الامونيوم ، احسب وزن كلوريد الامونيوم اللازم للحصول على الامونيا اللازمة ، ثم احسب وزن نترات الصوديوم اللازمة لتحضير حامض النتريك اللازم للتفاعل .

(١٢) ما وزن الماء المتكون عند اختزال ١٠٠ غم من اوكسيد النحاس باستعمال الهيدروجين وما حجم الهيدروجين في ظ.ق. اللازم للاختزال .

(يتبع) ..

كمبيالة رقم ٩

(٦) عند اختزال ٢٠ر٣ غم من اوكسيد فلز بغاز الهيدروجين نتج ٧٢ر٠ غم من الماء فاذا علمت ان الحرارة النوعية للفلز ٠٥٤ر٠ . فما الوزن الذرى المضبوط للفلز ؟ وما حجم الهيدروجين في الظروف القياسية الذى قام بعملية الاختزال .

(٧) اوكسيد فلز يحتوى على ٥٣٪ من الفلز وان وزن اللتر من هذا الاوكسيد في ظ.ق. هو ٦٤ر٤ غم احسب الوزن الذرى والتكافوء .

(٨) فلز يكون كلوريدين يحتوى احدهما على ٤٤ر١٪ والثاني على ٣٤ر٥٪ من الفلـــز فاذا كانت الحرارة النوعية له ١٢ر٠ احسب الوزن المكافيء والتكافوء لكل مـــن الكلوريدين والوزن الذرى المضبوط للفلز .

(٩) ٠٥٤ر٠ غم من فلز كون ٢٦٧ر٠ غم من الكلوريد احسب وزنه المكافيء واذا كـــان الفلز ثلاثي التكافوء احسب الوزن الذرى المضبوط للفلز .

(١٠) فلز حرارته النوعية ١١٤ر٠ وعند اختزال ٢٨٦ر١ غم ، ٤٣٠ر١ غم من اوكسيدين مختلفين اعطى كل منهما ٠٠ر١ غم من الفلز احسب التكافوء والوزن الذرى المضبــوط لهذا الفلز .

(١١) وجد ان ٦٧ر٦ غم من كلوريد احد الفلزات يحتوى على ٣٥ر١ غم من الفلز. فمـــا الوزن المكافيء للفلز ؟ واذا علمت ان الحرارة النوعية للفلز ٢٢ر٠ . فما الوزن الذرى المضبوط .

(١٢) ١ غم من فلز ثنائي التكافوء مثل x عند اذابته في حامض الكبريتيك المخفف اعطـــى ٤٢٣ سم٣ من الهيدروجين في درجة ١٥م٥ وضغط ٧٦ سم/زئبق احسب مكافـــيء الفلز ووزنه الذرى المضبوط .

(١٣) ٣٥٨ر١٠ غم من البوراكس المتبلور الذى صيغته الجزيئية $Na_2B_4O_7 \cdot 10H_2O$ اعطى ٤٧٨ر٥ غم من الملح اللامائي عند تسخينه وتجفيفه . فاذا علمت ان الـــوزن الذرى للصوديوم ٢٣ وللاوكسجين ١٦ والهيدروجين ١ احسب الوزن الـــذرى للبورون .

(يتبع) ..

كيار رقم ٦

٦٧/١٠/٣١ الكيمياء للصف الخامس الاعدادي الاستاذ طالح حسن

—١—

الأوزان الجزيئيـــة

١ـ الوزن الجزيئي للغاز او البخار = ٢ × كثافته النسـبية

٢ـ " " " " = الكثافة المطلقة له × ٢٢٫٤

٣ـ " " للمادة غير المتأينة = $\frac{\text{وزن المذاب} \times \text{ثابت الدرجة} \times ١٠٠}{\text{وزن المذيب} \times \text{مقدار الانخفاض او الارتفاع}}$

(١) ٠٫٦ غم من سائل عند تبخره شغل حجما قدره ١٧٦ سم٣ عند درجة ١٥٠ ْم وضغط ٧٥٠ ملم/زئبق . احسب الكثافة البخارية والوزن الجزيئي لهذا السائل .

(٢) احسب الوزن الجزيئي لغاز اذا علمت ان ٤١٥ سم٣ منه في درجة ١٨ ْم وضغط ٧٥٢ ملم/زئبق يزن ٢٫٥ غم .

(٣) ما هو حجم ٥ غم من رابع كلوريد الكاربون في درجة ٢٧ ْم وضغط ٧٥٠ ملم/زئبق اذا علمت ان الوزن الجزيئي ١٥٣٫٨٤ .

(٤) اذا علمت ان اللتر الواحد من مادة متطايرة في درجة ٤٠ ْم وضغط ٧٨٥ ملم/زئبـــق يزن ٨٦ر٤ غم احسب الوزن الجزيئي .

(٥) احسب وزن اللتر الواحد من غاز الأمونيا تحت الظروف القياسية اذا علمت ان الوزن الجزيئي ١٧

(٦) يحتوي محلول مائي على ٤٫٥ غم من مادة غير متأينة مذابة في ١٢٥ غم من الماء. وجد ان درجة انجماده ـ ٠٫٣٧٢ ْم احسب الوزن الجزيئي لهذه المادة .

(٧) اذيب ٤٫٨١ غم من سائل غير متطاير وغير متأين في ٢٥٠ غم من الماء فغلى المحلول في درجة ١٠٠٫١٧ ْم احسب الوزن الجزيئي لهذا السائل .

(٨) ما درجة انجماد وما درجة غليان محلول سكر القصب الناتج من اذابة ٣٠ غم من السكر في ١٥٠ غم من الماء اذا علمت ان الوزن الجزيئي لسكر القصب ٣٤٢ .

(٩) درجة انجماد نموذج من النفتالين ٨٠٫٦ ْم . وعند اذابة ٠٫٥١٢ غم من مادة في ٧٫٠٣ من هذا النموذج من النفتالين وجد ان المحلول انجمد في درجة ٧٥٫٢ ْم احسب الوزن الجزيئي للمادة المذابة اذا علمت ان ثابت انجماد النفتالين ٦٨ ْم .

(١٠) اي المحلولين يغلي في درجة اكثر محلول يحتوي ٤٠٪ وزنا من الكليسيرين ام محلول يحتوي على ٦٠٪ وزنا من الاسيتون اذا علمت ان الوزن الجزيئي للكليسرين ٩٢ وللأسيتون ٥٨ .

ـ يتبع ٢ ـ

الاستاذ فالح حسن — الكيمياء — ٢٦/١٠/١٩٦٧

للصف الخامس الاعدادي (العلمي)

(١)

الأوزان الجزيئيــــــــــــة

١ـ الوزن الجزيئي للغاز او البخار = ٢ × كثافته النسبية

٢ـ الوزن الجزيئي للغاز او البخار = الكثافة المطلقة له × ٢٢٫٤

٣ـ الوزن الجزيئي للمادة غير المتأينة = (وزن المذاب × ثابت الدرجة × ١٠٠) ÷ (وزن المذيب × مقدار الانخفاض او الارتفاع)

اسئلة على الأوزان الجزئية

(س١) ٠٫٦ غم من سائل عند تبخره شغل حجما قدره ١٧٦ سم٣ عند درجة ١٥ م° وضغط ٧٥٠ ملم / زئبق احسب الكثافة البخارية والوزن الجزيئي لهذا السائل ؟

(س٢) احسب الوزن الجزيئي لغاز اذا علمت ان ٤١٥ سم٣ منه في درجة ١٨ م° وضغط ٧٥٢ ملم / زئبق يزن ٢٫٥ غم ؟

(س٣) ما هو حجم ٥ غم من رابع كلوريد الكاربون في درجة ٢٧ م° وضغط ٧٥٠ ملم / زئبق اذا علمت ان الوزن الجزيئي ١٥٣٫٨٤ ؟

(س٤) اذا علمت ان اللتر الواحد من مادة متطايرة في درجة ٤٠ م° وضغط ٧٨٥ ملم / زئبق يزن ١٫٢٨٦ غم احسب الوزن الجزيئي ؟

(س٥) احسب وزن اللتر الواحد من غاز الأمونيا تحت الظروف القياسية اذا علمت ان الوزن الجزيئي ١٧ ؟

(س٦) يحتوي محلول مائي على ٤٫٥ غم من مادة غير متأينة مذابة في ١٢٥ غم من الماء . وجد ان درجة انجماده ـــ ٠٫٣٧٢ م° احسب الوزن الجزيئي لهذه المادة ؟

(س٧) اذيب ٤٫٨ غم من سائل غير متطاير وغير متأين في ٢٥٠ غم من الماء فغلى المحلول في درجة ١٠٠٫١٧ م° احسب الوزن الجزيئي لهذا السائل ؟

(س٨) ما درجة انجماد وما درجة غليان محلول سكر القصب الناتج من اذابة ٣٠ غم من السكر في ١٥٠ غم من الماء اذا علمت ان الوزن الجزيئي لسكر القصب ٣٤٢ ؟

(س٩) درجة انجماد نموذج من النفتالين ٨٠٫٦ م° وعند اذابة ٠٫٥١٢ غم من مادة في ٧٫٠٣ من هذا النموذج من النفتالين وجد ان المحلول انجمد في درجة ٧٥٫٢ م° احسب الوزن الجزيئي للمادة المذابة اذا علمت ان ثابت انجماد النفتالين ٦٨ م° ؟

(س١٠) اي المحلولين يغلي في درجة اكثر محلول يحتوي ٤٠٪ وزنا من الكليسرين ام محلول يحتوي على ٦٠٪ وزنا من الاسيتون اذا علمت ان الوزن الجزيئي للكليسرين ٩٢ وللاسيتون ٥٨ ؟

كنيا . رقم ١/ (

الصف

السادس العلمي - الكيمياء حص٤

٢٦) خليط يحتوي كاربونات الصوديوم النقية وكاربونات الباريوم النقية احتاج ٢٥ر٠ غم منه الى ٤٨ر٢٣ سم³ من (١ر٠ع) حامض لمعادلته التامة . ما النسبة المئوية لمكونات الخليط .
مامقدار (١ر٠ع) من الحامض اللازم لمعادلة ٢٥ر٠ غم من نفس الخليط باستعمال الفينول فثالين لمعرفة نقطة التعادل .

٢٧) نموذجين من الكاربونات عودلت بحامض قياسي فاحتاج النموذج الاول ٧ر٠ مرة بقدر ما احتاجه النموذج الثاني فاذا كان النموذج الاول هو كاربونات البوتاسيوم ، وكان النموذج الثاني خليطا من (١غم كاربونات الصوديوم) والباقي كاربونات الليثيوم . احسب مقدار كاربونات الليثيوم في النموذج الثاني اذا كان النموذجان بنفس الوزن .

٢٨) خليط يحتوي كلوريد الامونيوم وكلوريد الصوديوم يزن (٥ر٠ غم) اذيب في الماء واضيف اليه زيادة من هيدروكسيد الصوديوم ثم قطر المحلول الناتج وامتص غاز الامونيا في (١٠٠ سم³) من (١ر٠ع) حامض الهيدروكلوريك ثم احتاج المحلول المتبقي (٣٣ر٢٣ سم³) من (١٥ر٠ع) من قاعدة . احسب النسب المئوية لكل من مكونات الخليط .

٢٩) (٢غم) من مادة غذائية عند تحليلها تحررت الامونيا ثم امتصت في الماء وعودلت مع حامض الهيدروكلوريك احسب عيارية الحامض اللازم بحيث تكون قراءة السحاحة مساوية للنسبة المئوية للنتروجين في المركب .

٣٠) ثلاثة نماذج يزن كل منها (١غم) يحتوي كل نموذج على كاربونات الصوديوم ومادة غير فعالة او بيكاربونات الصوديوم ومادة غير فعالة او كاربونات الصوديوم وبيكاربونات الصوديوم . احسب النسبة المئوية لمكونات كل نموذج من المعلومات التالية :-

النموذج	مقدار الحامض باستعمال الفينول فثالين	مقدار الحامض اللاضافي باستعمال المثيل البرتقالي
١	٠٨ر١٢ سم³	٠٨ر١٢ سم³
٢	٠ر٠ سم³	٢٠ر٢٠ سم³
٣	٠٤ر١٠ سم³	٦١ر١٦ سم³

٣١) لأكسدة (١غم) من كبريتات الحديدوز الامونيوم احتاج (٥ سم³) من حامض النتريك .
ماحجم الماء اللازم اضافته الى (٥٠٠ سم³) من هذا الحامض لنحصل على حامض (١ر٠ع) .

٣٢) (٥٠ سم³) من محلول دايكرومات البوتاسيوم يحتوي ٢٥ غم في اللتر من الدايكرومات اضيف اليها حامض الكبريتيك ثم اضيف الى (١٤٠ سم³) من محلول كبريتات الحديدوز الامونيوم الحاوية على ستة جزيئات من ماء التبلور والتي تركيزها (٥٠٠غم) في اللتر . هل المحلول الناتج مؤكسدا ام مختزلا وما حجم (٠٤ر٠ع) من المحلول المؤكسد او المختزل اللازم لمعادلة المحلول .

الصف : السادس العلمي

الكيمياء

ص٣ــ تتمة أسئلة الكيمياء التحليلية الحجمية .

١٩) أذيب ١غم من كاربونات الكالسيوم النقية في ٤٠سم^3 من محلول حامض الهيدروكلوريك فوجد أن زيادة الحامض تحتاج الى ٢٥سم^3 من محلول هيدروكسيد الصوديوم لمعادلتها . (١٠)سم^3 من محلول هيدروكسيد الصوديوم احتاجت لمعادلتها ٤ر٨سم^3 من محلول الحامض الأصلي ، أحسب تركيز الحامض و القاعدة .

٢٠) ٣٥ر٤غم من مخلوط ملح الطعام و كاربونات الصوديوم اللامائية ، أذيبت في الماء المقطر و أكملت الى ١٠٠سم^3 . (٢٠)سم^3 من هذا المحلول احتاجت لمعادلتها ٥ر٧سم^3 من ١ر٠عيارى حامض الكبريتيك ، احسب النسبة المئوية لكل من الملحين في الخليط الاصلي .

٢١) احسب x في الصيغة ($FeSO_4 \cdot xH_2O$) من المعلومات التالية :ــ
٢ر١٢ غم من بلورات كبريتات الحديدوز أذيبت في ٥٠٠سم^3 من المحلول محمض . (٢٥)سم^3 من هذا المحلول احتاج الى ٩ر٢١سم^3 من عشر عيارى برمنكنات البوتاسيوم .

٢٢) وجد بالتجربة أن ٢٥سم^3 من مخلوط حامض الكبريتيك و حامض الهيدروكلوريك المخففين تعادل ٨ر٢٢سم^3 من محلول هيدروكسيد الصوديوم العشر عيارى ، فاذا كانت النسبة بين وزني الحامضين في مخلوطهما هي ١ : ٣ ار على الترتيب ، احسب وزن كل من الحامضين في لتر من محلولهما .

٢٣) أذيبت بلورات من صودا الغسيل المائية في الماء وكان المحلول يحتوى على ٣ر١٢غم في كل ٢٠٠سم^3 ثم وجد أن ٢٠سم^3 من هذا المحلول تتعادل مع ٨ر٢١سم^3 من محلول عشر عيارى لحامض الكبريتيك ، احسب النسبة المئوية لماء التبلور في بلورات صودا الغسيل .

٢٤) احسب وزن اوكزالات الصوديوم اللامائية و حامض الاوكزاليك المتبلور $H_2C_2O_4 \cdot 2H_2O$ في اللتر من محلولهما من المعلومات التالية :ــ
٢٥سم^3 من المحلول يحتاج ٨ر١٩سم^3 من ١ر٠ع هيدروكسيد الصوديوم للتعادل باستعمال الفينول فثالين ، ٢٥سم^3 من نفس المحلول يحتاج ٢ر٣٤سم^3 من ١٠٦ر٠ع من برمنكنات البوتاسيوم للأكسدة .

٢٥) احسب وزن كبريتات الحديدوز و كبريتات الحديديك في اللتر من محلولهما اذا علمت أن ٢٥سم^3 احتاجت ٦ر٢١سم^3 من ١٠٥ر٠ع من برمنكنات البوتاسيوم للتأكسد وبعد اختزال نفس الحجم من المحلول بواسطة ملغم الزنك و جد أنه يحتاج ٨ر٢٢سم^3 من برمنكنات البوتاسيوم زيادة على احتياجه في الحالة الاولى للاكسدة .

الصف :
بكد العلمي
الكيمياء
مي

١٠ *) ٩ر٣غم من صودا الفسيل اذيبت في الماء وأكمل المحلول الى ٢٥٠سم٣، ٣ر٢٧سم٣ من عشر عيارى حامض الكبريتيك احتاجت لمعادلتها ٢٥سم٣ من هذا المحلول أحسب:
١ـ النسبة المئوية لوزن كاربونات الصوديوم في النموذج .
٢ـ عدد جزيئات ماء التبلور في كاربونات الصوديوم.

١١) ٥٠سم٣ من محلول نترات الرصاص، أضيف لها ٥٠سم٣ من محلول حامض الكبريتيك ١ر١ع فترسبت كبريتات الرصاص ترسيبا تاما و وجد أن زيادة الحامض احتاجت الى ٢٠سم٣ من عيارى هيدروكسيد الصوديوم. ما وزن نترات الرصاص بالغرامات في اللتر من المحلول ؟

١٢) خليط من صودا الفسيل و بيكاربونات الصوديوم تعادلت مع ٧٥ر٠ عيارى حامض الهيدروكلوريك بحيث أن ٨ر١غم من الخليط احتاجت الى ٢٣سم٣ من الحامض، فاحسب النسبة المئوية للخليط.

١٣) أذيب ١غم من كاربونات أحد الفلزات في ٢٥سم٣ من عيارى حامض الهيدروكلوريك فوجد أنه يلزم ٥ر١٠سم٣ من عيارى هيدروكسيد الصوديوم لمعادلة الحامض المتبقي فاحسب مكافئ كاربونات الفلز.

١٤) يحتوى حامض الكبريتيك التجارى على ٥٪ من وزنه ماء فاذا كان وزنه النوعي ١٫٨٤ فما تركيزه العيارى ؟

١٥) ما حجم ثاني أوكسيد الكاربون تحت ظ.ق. اللازم للتفاعل مع لتر من محلول هيدروكسيد الباريوم الذى تركيزه العيارى ١/٥ ع ؟

١٦) نحتاج ٤ر٢١سم٣ من محلول حامض الكبريتيك لمعادلة ٢٥سم٣ من محلول هيدروكسيد الصوديوم الحاوى ٢٠غم من في اللتر، احسب قوة الحامض مقدرة بالغرامات في اللتر من محلوله.

١٧) خليط من ٢غم من هيدروكسيد الصوديوم مع ٥ر٢غم من كاربونات الصوديوم المائية أذيبت في الماء واكمل المحلول الى لتر، ما حجم عيارى حامض الهيدروكلوريك اللازم لمعادلة ٥٠ سم٣ من هذا المحلول.

١٨) ٢٠سم٣ من يحتوى على حامضي النتريك والهيدروكلوريك. يحتاج لمعادلته التامة ٥ر١٠سم٣ من عيارى هيدروكسيد الصوديوم و عند الترسيب باستعمال زيادة من نترات الفضة وجد أن ٢٠سم٣ من المحلول الأصلي يعطي ٩٨ر٠ غم من كلوريد الفضة، احسب وزن كل من الحامضين في لتر من المحلول الأصلي.

يتبع ص٣......

الصف :-

السادس العلمي

الكيمياء

ص ١

الصف السادس العلمي 				٢٥/ ٢/ ١٩٧٠

الكيمياء التحليلية
الكمية

١) أوجد دالة الحموضة (PH) ودالة القاعدية (POH) لمحلول حامض الهيدروكلوريك ٠٠٠٤ر٠ مولارى.

٢) أحسب تركيز أيون الهيدرونيوم في محلول ، اذا علمت أن دالة الحموضة فيه (PH) تساوى ٨ر٤.

٣) أحسب دالة الحموضة في درجة ٢٥^{o}م لمحلول ١ر٠ مولارى من سيانيد الصوديوم.

٤) أحسب تركيز أيونات الهيدروكسيد في محلول ١ر٠ عيارى من حامض الكبريتيك.

الكيمياء التحليلية
الحجمية

١) ٢٠٠سم^{٣} من محلول الصودا الكاوية احتاجت لمعادلتها ١٠٠سم^{٣} من محلول حامض الهيدروكلوريك الحاوى على ٣ر٧غم من الحامض في اللتر. أحسب تركيز الصودا الكاوية في محلولها.

٢) ما حجم هيدروكسيد الصوديوم الحاوى على ٢٠غم/لتر الذى يحتاج لمعادلته ١٠٠سم^{٣} من محلول حامض الكبريتيك الحاوى على ٢٥ غم/لتر.

٣) محلول من البوتاسة الكاوية يحتوى على ٩غم/لتر من KOH ما حجم حامض الكبريتيك المخفف الحاوى على ٨غم/لتر من الحامض اللازم لمعادلة ٢٥سم^{٣} من البوتاسة الكاوية. وعند تبخير المحلول المتعادل ، ما وزن الراسب المتكون.

٤) أحسب حجم محلول حامض الكبريتيك الحاوى على ٤غم/لتر من الحامض اللازم لمعادلة ٢٠٠سم^{٣} من غاز الأمونيا في ظ.ق.

٥) أذيب ١غم من هيدروكسيد الصوديوم الصلب في ٥٠سم^{٣} من عيارى حامض الهيدروكلوريك ، ما حجم عيارى هيدروكسيد الصوديوم اللازم لمعادلة الحامض المتبقي.

٦) ١٠٠سم^{٣} من حامض النتريك تفاعلت مع كاربونات الكالسيوم النقية "الكلسايت" فأذابت ٨٥ر١غم من البلورات. احسب تركيز الحامض.

٧) وجد أن ٢٠سم^{٣} من محلول يحتوى على ٥ر٦٢غم/لتر من صودا الغسيل التجارية $Na_2CO_3 \cdot 10H_2O$ احتاجت لمعادلتها الى ٩٥ر١٣سم^{٣} من نصف عيارى حامض الكبريتيك فما النسبة المئوية للنقاوة في المادة.

٨) ٦ر٠غم من أحد الفلزات أذيب في ١٠٠سم^{٣} من عيارى حامض الكبريتيك فوجد بعد ذلك أنه يحتاج الى ٥٠سم^{٣} من عيارى قاعدة لمعادلته ، ما مكافئ الفلز.

٩) ٣٨ر١٦غم من حامض ثنائي القاعدة يحتوى على جزيئتين من ماء التبلور أذيب في الماء وأكمل المحلول الى ٢٥٠سم^{٣}، ٢٥سم^{٣} من هذا المحلول احتاجت لمعادلتها ٢٦سم^{٣} من عيارى كاربونات الصوديوم. احسب :-

١- الوزن المكافئ لبلورات الحامض.

٢- الوزن الجزيئي للحامض اللامائي.

[illegible]

[illegible]

[illegible]

[illegible]

 12/14/1986

Pure Mathematics- G.C.E 'A' Level

Supplementary Exercises

From

Sixth Form Pure Mathematics- By C. Plumpton & W.A.Tomkys Vol.I

Page 30

Miscellaneous Exercises I

5. A curve whose equation is of the form $y=ax^2 + bx + c$ crosses the y-axis at right angles at the point where $y = 12$ and also passes through the point $(3, -15)$. Find

(i) the values of a, b and c;

(ii) the coordinates of the points at which the curve crosses the x-axis;

(iii) the gradients of the curve where it crosses the x-axis. (N.)

6. Find the equation of the tangent and the equation of the normal to the curve $y=(3-2x^2)^2$ at the point where $x = 1$. (N.)

8. If the abscissae of three points P, Q, R on the curve $y=x^2+x+1$ are x, $x - h$, $x + h$ respectively, show that the chord QR has the same gradient as the tangent to the curve at P.

9. The total running cost of a ship per hour is £$(13+\frac{v^2}{52})$ where v knots is the speed. If £C is the cost per nautical mile, write down an equation expressing C in terms of v; hence find the speed at which the cost per nautical mile is least.

The ship makes a voyage of 800 nautical miles at a speed of 13 knots. How much money would have been saved if the journey had been made at minimum cost? (N.)

11. A block of ice in the form of a cube, whose edge is 2 m, begins melting, and its volume decreases at a constant rate, the block remaining cubical. If the rate of melting is such that the edge measures 1 m after 28 hours, find

(i) the length of the edge after 16 hours;

(ii) the rate at which the length of the edge is decreasing at that time. (N.)

12. Find the maximum and minimum values of the function $\frac{1}{3}(4x^3-3x-1)$. Sketch the curve $y=\frac{1}{3}(4x^3-3x-1)$ and find the greatest and least values of y for values of x in the range -1.5 to $+1.5$ inclusive. (N.)

(cont'd.p.2)..

Taken from papers III & IV G.C.E. Advanced Level

Applied Math. Jan. 1965

9. A particle is suspended from a fixed point by a light inextensible string of length l and is given an initial horizontal velocity of $\sqrt{(5gl)}$. Prove that it will just be able to describe a complete vertical circle provided that the string can sustain a tension of not less than six times the weight of the particle.

If in fact the string can sustain a tension of only three times the weight of the particle find the greatest initial horizontal velocity which can be given the particle without breaking the string, and determine in this case where the particle will come to instantaneous rest.

10. (i) Prove that if a particle is suspended from a fixed point by an elastic thread and is displaced vertically from its equilibrium position it will execute simple harmonic motion.

(ii) A light elastic thread OP of natural length a and modulus of elasticity 2mg lies on a smooth horizontal table. The end O is tied to a fixed point on the table and a particle of mass m is tied to the end P. The thread is just taut and P coincides with a point A on the table. The particle is pulled along the table directly away from O until $OP = 3a/2$ and is then released from rest. Find

(a) the time it takes to return to A for the first time,

(b) the further time that elapses before it returns to A for the second time,

(c) the speed of the particle when $OP = 6a/5$.

-----

9. A particle is suspended from a fixed point by a light inextensible string of length l and is given an initial horizontal velocity of $\sqrt{(5gl)}$. Prove that it will just be able to describe a complete vertical circle provided that the string can sustain a tension of not less than six times the weight of the particle.

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(a) the time it takes to return to A for the first time,

(b) the further time that elapses before it returns to A for the second time,

(c) the speed of the particle when $OP = 6a/5$.

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5. A is the upper and B the lower of two points distant d apart on a line of greatest slope on a plane inclined to the horizontal at an angle $\tan^{-1} \frac{3}{4}$. A particle rests on the plane at A, its coefficient of friction with the plane being 4/5. Show that the speed with which it must be projected down the plane in order just to reach B is $\frac{1}{5}\sqrt{(2gd)}$, and that if it is then projected up the plane from B with the same initial speed it will only travel a distance d/31 before coming to rest.

   The particle is removed and a second particle, whose coefficient of friction with the plane is 3/4, is projected down the plane from A with the same initial speed. Show that it reaches B in half the time taken by the first particle.

6. A ball is projected under gravity from a point A on level ground directly towards a tall vertical mast 108 ft away and strikes the ground at the foot of the mast. Show that during its flight the ball when viewed from A will appear to be descending the mast with uniform speed.

   Viewed from A the ball appears at one moment to be passing a point P on the mast and half a second later to be passing a point Q 24 ft below P. Find the initial velocity of the ball and its time of flight.

   (Take g as 32 ft per sec^2).

7. An engine of 300 horse-power can just pull a train of mass 200 tons up an incline of 1 in p (i.e., $\sin^{-1} 1/p$) at a speed of 15 miles an hour, the road resistance being 11 lb wt per ton.
   Find the value of p to the nearest integer.

   Find the maximum speed which the train will be able to reach when the track becomes level, the road resistance remaining as before.

   If the train, when travelling on the level at this maximum speed, can be stopped in one mile by shutting off steam and applying the brakes, find the braking force in lb wt per ton.

   (Take g as 32 ft per sec^2).

8. Two parallel walls of a room are 12 ft apart. A point P on the floor is 3 ft from one wall and a point Q is 4 ft from the other wall, the line PQ being perpendicular to the walls. A particle is projected with speed 1 ft per sec from P directly towards the nearer wall and simultaneously a second particle is projected from Q with speed 2 ft per sec directly towards the wall nearer to it. The floor is smooth and the coefficients of restitution between the particles and the walls, and between the particles themselves, are in each case 3/4. The particles meet at a point X and the first particle is brought to rest by the impact. Find the distance of X from the nearer wall and the ratio of the masses of the particles.

   Find also the time that will elapse before a second collision between the particles occurs.

(p.3)...

GENERAL CERTIFICATE OF EDUCATION
EXAMINATION

JANUARY 1965
Advanced Level

MATHEMATICS III
Applied Mathematics

Three hours
Answer EIGHT questions.

1. A uniform beam of weight W rests with one end on smooth horizontal ground and the other end on a smooth plane. The beam and the plane make angles θ and α respectively with the same direction of the horizontal and the beam is perpendicular to the line of intersection of the plane and the ground. Prove that the horizontal force P which will have to be applied to the lower end of the beam to maintain equilibrium is

$$\frac{W \tan \alpha}{2\,(1 + \tan \alpha \tan \theta)}$$

and deduce the force which would have been required had the plane been vertical.

Find what increase in P will be necessary to maintain equilibrium when a weight W is attached to the beam one-quarter of the way up the beam.

2. (i) OABC is a rectangle. O is the point (0,0), A the point (2,0) and B the point (2,1), the unit of measurement along each axis being 1 ft. Forces of P, Q and R lb wt act respectively along OA, AB and BC in the directions indicated by the order of the letters. Their resultant lies along the line $x + 2y = 7$. Find the magnitude of the resultant in terms of P.

Find also the moment of a couple which when added to the system would transfer the resultant to the line $x + 2y = 9$.

(ii) O is any point in the plane of a square ABCD whose diagonals intersect at E. Four forces are represented completely by $3\overrightarrow{OA}$, $2\overrightarrow{OB}$, $3\overrightarrow{OC}$ and $2\overrightarrow{OD}$. Show that their resultant passes through E, and find its magnitude in terms of OE.

3. A uniform lamina ABCED of weight W has the shape of a square ABCD on the side CD of which a triangle CED has been described externally to the square. CE = ED and the angle CED = 2α. The lamina is placed in a vertical plane with the side AD in contact with a horizontal table and it topples in that plane about D. Prove that $\tan \alpha < \sqrt{3}/6$.

It is required to prevent this toppling by applying the least possible force to the lamina at one of the points A, B, C or E. Find which point should be chosen, and calculate the minimum force required in terms of W and α.

4. A uniform rod of weight 4W and length 2a is maintained in a horizontal position by two light inextensible strings each of length a attached to the ends of the rod. The other ends of the strings are attached to small rings each of weight W which can slide on a fixed rough horizontal bar with which the coefficients of friction are each ½. Show that in equilibrium the distance between the bar and the rod cannot be less than $4a/5$, and find the greatest and least possible distances apart of the rings.

(p.2)..

حامد السامرائي

١	اللغة العربية	للصف الاول المتوسط	(أ)
٢	"	" " "	(ب)
٣	التربية	" " "	(جـ)
٤	"	" " "	(أ)
٥	اللغة العربية	" الثاني "	(أ)
٦	"	" " "	(ب)
٧	التربية	" الثاني المتوسط	(أ)
٨	"	" " "	(ب)
٩	اللغة العربية	" الثالث المتوسط	
١٠	التربية	" "	

(١٩) عند اذابة ٣ غم من مركب عضوي في ١٠٠ غم من الفينول وجد ان الانخفاض في درجة الانجماد للفينول ٠ر٦١ °م فاذا علمت ان ثابت انجماد الفينول ٧ر٣٨ °م احسب الوزن الجزيئي للمركب العضوي الاصلي .

(٢٠) أذيب ٢ر٣٦٥ من مادة عضوية وزنها الجزيئي ٥ر٠٨ في ٥٠٠ غم من سائل مـــا فانخفضت درجة انجماد ذلك السائل المذيب بمقدار ٠ر٤٦٥ °م . وعند اذابـــة ٤ر٥ غم من مادة ثانية في ١٢٥ غم من نفس السائل المذيب انخفضت درجة انجماده بمقدار ٠ر٥٨ °م احسب من ذلك الوزن الجزيئي للمادة المذابة الثانية .

(يتبع) ..

کمیا - رقم ۲

EXPERIMENTAL PROOF OF ARCHIMEDES' PRINCIPLE :-

A very good method of demonstrating the truth of the principle is by using the bucket-and-cylinder. The apparatus consists of a small brass bucket into which a solid cylinder can just fit; thus the cylinder is of the same volume as the inside of the bucket. The cylinder can also be taken out of the bucket and attached to the bottom of the latter by means of a hook. Attach the cylinder to the bottom of the bucket, and suspend the whole from the hook of the beam of a balance. Place weights in the right hand pan to secure an accurate balance. Then bring a beaker of water resting on a bridge under the cylinder and raise it until the cylinder is just completely immersed. The right-hand side will now be heavier than the left owing to the upthrust of the water on the cylinder, but without distributing the weights on the pan, equilibrium can be restored by gently pouring water into the bucket. The two sides will exactly balance when the bucket is completely full of water, therefore the apparent loss in weight is equal to the weight of water displaced, in accordance with the principle of Archimedes. In this experiment there is no need to find the actual value of the weights in the right-hand pan.

Applications of Archimedes' Principle :-

1. To find the S.G. of a solid :-

The S.G. of a body is defined as the ratio of its weight to the weight of an equal volume of water. Since a submerged body displaces a volume of water equal to its own volume, however irregular it may be :-

$$\therefore \text{Specific G. of body} = \frac{\text{Weight of body}}{\text{Weight of water displaced}}$$

Consider the following example :-

Q. A platinum ball weighs 330 gm. in air, 315 gm. in water; find the S.G. of platinum ?

A. Weight of displaced water = 330 - 315 = 15 gm.; and this weight of water has the same volume as the platinum ball.

$$\therefore \text{S.G. of platinum} \quad \frac{\text{Weight of platinum}}{\text{Wt. of equal volume of water}} = \frac{330}{15} = \underline{\underline{22}}$$

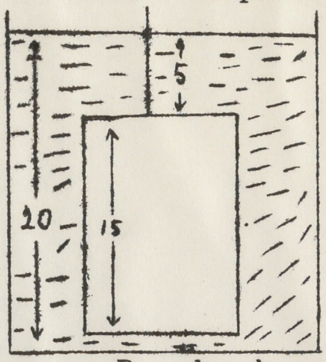
(cont'd.P.12)......

The Principle of ARCHIMEDES :-

Cork and wood float on water. When we swim, our bodies are held up almost entirely by the water. Even an object that sinks, such as a large stone, may be carried more easily when under water. A man in a bath tub can support his whole weight by pressing lightly against the bottom with his fingers. These phenomena illustrate the buoyant force of the liquid, or the force which tends to push the body upward when it is put in the liquid. This behaviour of the liquid is referred to as BUOYANCY.

Let us now consider the following problem :-

Q. A rectangular block of metal measuring 15cms x 6cms x 4cms is suspended vertically in water so that its top surface is 5cms below the water surface. Calculate
(i) The forces acting on the top of the body,
(ii) On the base of the body,
(iii) The weight of the water displaced.



A. Because the top of the body is 5cms below the surface, $\therefore P = d \times h$

$= 1 \times 5 = 5$ gms/sq. cm.

Down ward thrust $= P \times A$

$= 5 \times 6 \times 4 = 120$ gms.

The base of the body is 20cms (15 + 5) below the surface :-

$\therefore P = d \times h$

$= 1 \times 20 = 20$ gm/sq.cms.

Upward thrust $= 20 \times 6 \times 4 = 480$ gms.

$\therefore$ The net force acting on the body :-

$= 480 - 120 = 360$ gms., which is the buoyant force.

Volume of body $= 15 \times 6 \times 4 = 360$ c.c.

Wt. of displaced water $= V \times d$.

$= 360 \times 1 = 360$ gms.

From the above example we can see that the weight of the displaced water is equal to the buoyant force, or it is equal to the weight of the body, which had been lost, when it was immersed in the water. This is known as Archimedes' Principle, which usually states :-

" WHEN A BODY IS IMMERSED IN A LIQUID, THE UPWARD THRUST IS EQUAL TO THE WEIGHT OF THE LIQUID DISPLACED."

or: ANY BODY IMMERSED IN A LIQUID APPARENTLY LOSES A WEIGHT EQUAL TO THE WEIGHT OF THE DISPLACED LIQUID."

(cont'd. P.11)............