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THE

# SCHOOL MAGAZINE.

SEPTEMBER—OCTOBER, 1881.

## HEALTH DEPARTMENT.

*Editor: A. Hamilton, M. A., M. D., Port Hope, Ont.*

### SCHOOL-ROOM VENTILATION.

VENTILATION is the supply of fresh air to an apartment, and the removal of impure or vitiated air therefrom. An adequate supply of free oxygen is absolutely necessary to animal life; and, the higher we ascend in the scale of that life, the greater the quantity of oxygen consumed, and the more urgent the necessity for its consumption. In the atmosphere this oxygen exists in a free state - in mechanical solution -and in the form and proportion in which it is most easily assimilable. From the atmosphere, the animal absorbs it by means of its breathing apparatus which provides for its absorption by the blood, and the blood carries it to the tissues. *Pure air* consists of a mechanical mixture of about four-fifths nitrogen and one-fifth oxygen, with traces of ammonia, and about one part in two thousand of carbonic-acid gas ($CO_2$). These latter (ammonia and $CO_2$), from their small amount, may be neglected.

Air becomes vitiated for breathing purposes by holding in solution other gases or substances whose presence interferes with the appropriation of oxygen by the animal, or, being themselves absorbed, exert a toxic influence upon the vital fluid and tissues of the body. Hence, to secure an adequate supply of fresh air, and the removal of impurities that accumulate therein, are the objects of ventilation. In this paper school-room ventilation only will be considered.

A full-grown person breathes on an average about twenty times per minute, and takes in over twenty cubic inches of air at each inspiration. Boys and girls inspire somewhat less than twenty cubic inches, but breathe more rapidly than an adult -say twenty-five times per minute. In five minutes each will breathe over a cubic foot of air, and in a two hours session nearly twenty-five cubic feet, so that, in a school of forty pupils, one thousand cubic feet will be inhaled every two hours. This is under, rather than above, the average.

Oxygen to the amount of nearly five per cent. of the quantity inhaled disappears at every breath, being absorbed by the blood —or twenty cubic inches per minute for each individual — representing a total of fifty cubic feet for a school of forty pupils during a two hours session. But, in addition to

the consumption of oxygen, the air is further deteriorated by the exhalation of nearly as much carbonic-acid gas ($CO_2$) as there is oxygen consumed—say forty-five feet in two hours, about one-fortieth of the total amount produced being thrown off by the cutaneous surface of the body. Each cubic foot of carbonic acid gas contains nearly half an ounce of pure carbon, or twenty-three ounces in all, so that, by breathing, forty mouths—like veritable little chimneys—puff off in two hours an amount equal to about a pound and a-half of solid carbon. This is injurious in two ways, each of which will be examined in the proper place.

The air occasionally contains many impurities, but only those usually found in the school-room will here be enumerated. They are carbonic oxide (CO), carbonic-acid gas ($CO_2$), ammonia ($NH_3$), sulphur (S), sulphuretted hydrogen ($H_3S$)—all in the gaseous form; to which must be added aqueous vapor, organic matters, inorganic matters, epithelial cells, and animal exhalations.

The most toxic of all these is undoubtedly carbon monoxide (CO). It is a product of the incomplete combustion of carbon (C), but happily it is not usually found in the school-room in any large amount. A fire is the result of the chemical combination of the carbon of coal or other combustible, with the oxygen (O) of the air; the atoms of the gas rush into combination with those of the carbon, and the arrested motion is transformed into heat—aqueous vapor ($H_2O$), carbon monoxide (CO), and carbonic acid gas ($CO_2$), being produced. If a sufficient supply of air has free access to the *lower* portions of the fire, carbonic acid gas is directly formed; but this, in its passage upward through the central portion of the fire, where the temperature is higher, takes up another atom of carbon ($CO_2 + C = CO + CO$) and becomes carbon monoxide or carbonic oxide, as it is commonly called. This carbonic oxide, on reaching the upper surface of the fire, takes up an additional atom of oxygen from the air, and, burning with a bluish flame, becomes carbonic acid gas once more, and makes its escape by the chimney. But usually a portion of the carbonic oxide fails to take up the additional atom of oxygen; and, when the supply of air is limited, the amount is increased, so that more or less carbonic oxide passes up the chimney along with the other gases of combustion. As the products of combustion are much lighter than the surrounding atmosphere—volume for volume—on account of their much higher temperature, and as the expansibility of gases is very great, they exert a pressure upon the sides of the pipe or flue through which they ascend. This being the case, these gases will escape through chinks, holes or defective joints, along their course, like steam through a leaky conduit. Downward air-currents in the flue, and lateral currents from open windows, etc., occasionally blow large quantities of the gases of combustion through the open door of the stove, or through seams or cracks therein; and in these two ways—through stove and flue—sulphur, carbonic oxide and carbonic acid gas may find their way into the room. It is claimed by some physicists that carbonic oxide will make its way through heated iron, and thus escape through the sides of the stove, but the quantity given out in this way—if, indeed, any is given out, of which there is reasonable doubt—must be so small that it is practically of no account, while quantities large enough to be decidedly injurious may issue through the door and other openings. Of course, these remarks apply only to schools heated by stoves; but it must not be forgotten that in rural districts and many cities, all the schools are still heated in this way.

Carbonic oxide is a deadly poison,

fixing itself in the blood-corpuscles and paralyzing them so that they cannot carry on the function of respiration. To the inhalation of this gas is chiefly due the pale color of those who spend much time in apartments heated by stoves and poorly ventilated. Its presence cannot be recognized by the senses, as it is tasteless, colorless and inodorous.

Carbonic acid is produced in two ways, as before explained—by combustion and by breathing. The quantities thrown off in breathing is very much increased—often nearly doubled—during *active digestion.* As the fullest meal is taken at dinner, and digestion is most active soon after, it follows that the exhalation of carbonic acid gas is greatest during the early part of the afternoon, and therefore during this time ventilation needs more attention. Of all the impurities found in the school-room, this is vastly the largest in amount, and popularly considered the most important. It is once and a-half as heavy as air. At first sight, it might be supposed that, being heavier than air, it would sink to the floor and settle there in a layer of uniform height and density, like so much water. But this is not the case for it is even more expansible than air. (Coefficient of expansion of air = .00366; of $CO_2$ = .00371.) Now, the laws which governs the mixtures of gases is this:

*The mixture of gases in free communication, whatever their density, takes place rapidly, and is homogeneous*—that is, the mixture contains the gases in the same proportion; so that the percentage of carbonic acid gas is about the same in all parts of the room.

If ample provision is not made for the removal of the vitiated air, the proportion of carbonic acid gas continues to increase; and, as it is much heavier than air, the density becomes greater. Now, this increase of the air's density interferes with and retards the diffusion between the impure gases held in solution in the blood and the oxygen of the atmosphere—in other words interferes with respiration. The consequence is that the blood is not purified of the carbonic acid gas which it holds in solution and combination. Not being removed as fast as it is formed in the body, it accumulates in the blood; the blood carries it throughout the system, circulating it through the delicate tissues of the brain. As the brain is the organ of the mind, it is by and through the brain that we think, reason, memorize, learn. For its healthy and vigorous action, a full supply of pure blood is an imperious necessity. The effects produced by this gas, when circulating through the brain in excess, are drowsiness, dizziness, dull head-ache, an inability to fix the attention, a dislike for application, a weakening of the memory, and a general torpor of the intellectual powers. An explanation of how and why these effects are produced would involve certain principles of mental physiology—a subject not within the scope of this paper.

Special attention is requested to this statement by Dr. Routh:* "Experiment has shown that if an animal be kept confined in a narrow, closed apartment, so that the air supplied is always more or less vitiated by the carbonic acid which it expires, however well fed that animal may be, tubercle (consumption) will be developed in about three months." If this be the case, a large percentage of cases of consumption should be met with among the inmates of badly ventilated schools. But, fortunately, the disease is comparatively infrequent under the age of fifteen, and added to this is the protecting influence of the active exercise in the open air usually indulged in by school-children. It is upon the teachers that its blighting effects are most apparent, as they are predisposed by

* "Infant feeding," part iv., chap. iv.

age, they neglect exercise in the open air, and *their mental labor is severe, and worry of mind exhausting.* Of eleven teachers who died during the last eight years within the limits of one county in Pennsylvania, two died of acute disease, one of an overdose of an habitual narcotic, and of nine attacked by consumption, eight died—six ladies and one gentleman; the other a gentleman, will recover, at least for a time.

The organic matters suspended in the air are derived *(a)* from the body; *(b)* from other sources. Epithelial cells or scales, very minute, arise by desquamation from the external cutaneous surface, and also from the mouth, pharynx and bronchi. Being exceedingly light, they float in the air and are inhaled, lodging in the throat, trachea and even deep in the lungs. It is not pleasant to contemplate the fact that we inhale minute portions of each other's bodies, but it is true nevertheless. In diphtheria, scarlatina, smallpox, measles, etc., these epithelial scales come off in vastly greater quantities than in health, carrying with them, in greater or less virulence, the peculiar infection in the body whence they have arisen. The greater their number and the more favorable the nidus in which they become deposited, the more likely they are to become transplanted as primary centres of infection. Hence it is important to prevent their *accumulation*, as the greater their numbers the greater the probability of their successful transplantation; and as they float in the air they follow its currents and are thus removed by ventilation. Other sources of organic matter are various and numerous, but, with the following exception, of little importance in the present connection.

The cutaneous surface and the lungs give out certain odors, *sui generis*, which are designated "animal exhalations." It is to these that the heavy, sickening smell noticed on first entering a crowded room is due. Odors being volatile and exceedingly light, these exhalations rise to the highest portions of the room; and, if not allowed to escape, accumulate there, saturating the air from above downward, and finally reaching the floor. Of all the noxious matters in the fouled air of a poorly ventilated school or public building, these are at once the most perceptible, the most offensive, and the most rapidly prostrating. They produce a sensation of stifling by their irritation of the branches of the pneumogastric nerve distributed to the lungs and larynx, and nauseate, probably by reflex action, through branches of the same nerve distributed to the stomach. A distinguished physician, writing of an infant nursery under his charge where the children did not thrive, and many died of diseases of the digestive organs, says: "One remarkable circumstance observed was that there was a faint odor always present in the room. Yet it was a large room, about fifty feet in length. One side of the room was made up of windows which went up about ten feet where the roof or ceiling beveled up in an inverted ∧ shape, which raised the room in the centre seven or eight feet more. Do what I would, I could not get rid of this smell. One day, being much annoyed thereat, I procured some long steps which extended about three feet above the upper ledge of the windows. On walking up, no sooner had I got my head one foot above their level, than I found a terrible odor that made me feel giddy and sick, and I was glad enough to come down. I instantly sent for a workman and desired him to remove three or four tiles at each end of the room, on a level with the highest point of the roof. He did so. In ten minutes all odor had disappeared; but his work was no sooner ended than he was taken very giddy and practically sick, so completely had he been overcome by the pestilential atmosphere."

This incident will again be referred to in speaking of ventilators.

In regard to the moisture of the air, the following may be said: The drier the air, the more rapidly are the liquids of the body evaporated, and digestion and assimilation carried on, the more nervous is the temperament, and the more rapid the development. Generally speaking, the air is much drier in the United States than in Europe. This is the chief reason why our children are less repressible, livelier and more nervous and precocious than those of Europe. Another reason is, that we use here more animal food, which is far more stimulating both to body and mind than vegetable. On the other hand, too dry an atmosphere is unhealthy. As children drink much water, they exhale much aqueous vapor—the sweat-glands and capillary circulation being more active than in the adult—say to the amount of half a pint each, more or less, during school hours. As such a large amount of invisible vapor arises, it serves a useful purpose by adding to the moisture of our dry air, rather than being injurious. In dwellings it is sometimes customary to place a vessel of water upon the stove to produce vapor, so as to diminish the dryness of the air; but, for the reason given above, it is perhaps unnecessary in a school-room. However, as water absorbs equal volumes of carbonic acid gas, and four hundred and thirty volumes of ammonia, a shallow vessel of water may in this way be of some service.

*The inorganic matters* consist of chalk-dust, earth-dust, ashes, etc. Of late years, owing to the large amount of blackboard work done in schools, particularly in the primary departments, chalk-dust floats in large quantities in the air whenever the erasers are used. The particles of chalk-dust are comparatively large in size. When inhaled, it lodges in the posterior portion of the nasal passages and upper portion of the larynx; and when settled in large amount in these locations it gives rise to a good deal of irritation. The effect of this irritation is the secretion of a tenacious mucus that provokes distressing cough and unpleasant hawking. It is easy to understand how this exciting cause, long continued, may produce a chronic catarrh of these regions, especially in the posterior nasal passages, as they are prone to congestion and a low grade of chronic inflammation. The same remarks apply, but in a far less degree, to ash and earth-dust. The frequent cough and occasional sneeze heard among the audience in theatre, hall or church, are provoked by the inhalation of fine dust suspended in the air, and might be prevented by careful sweeping and dusting after occupancy. The school-room should be swept every evening and dusted at least an hour before opening. The blackboards should be erased as little as possible, and preferably by the so-called "dustless" erasers — though, strictly speaking, no eraser is really "dustless," being simply "less dusty" —and then gently in an up-and-down direction, so that the dust may not be dispersed through the room. The floor should not be disturbed by sweeping at any time during the day. Having examined briefly the different substances that vitiate or foul the air contained in a school-room, and the sources from which they are derived, the means of effecting their removal therefrom will next be discussed.

The chief factors in carrying on ventilation are *(a)* the difference in temperature between the outside air and that within the room, and *(b)* the diffusibility of gases.

It is the difference *in temperature* that produces a draught up a flue or chimney when a fire is lighted below; for the products of combustion have a very much higher temperature (several hundred degrees Fahr.) than the surrounding atmosphere. Being so much

warmer, they are lighter in consequence (as will be explained presently), and therefore have a constant tendency to ascend—being compelled by the force of gravity—till, after cooling little by little, they reach a layer of their own temperature. Upon the same principle an inflated balloon ascends and a cork immersed in water constantly tends to rise to the surface. As the coefficient of expansion for gases equals about $\frac{1}{273}$—i. e., they increase about $\frac{1}{273}$ of their bulk for every degree centigrade increase in temperature, *thus becoming lighter in proportion to their volume*, and are compelled by gravitation to ascend. It is important that the pipe or flue in rooms heated by stoves or grates should be vertical or nearly so; also, that it be not too wide, otherwise downward currents will be produced, and these interfere with the draught and cause the gases of combustion to escape into the room. In a stove-pipe the elbows should be as few in number as possible, and rounded rather than acute; for a sharp or abrupt bend materially diminishes the velocity of the draught. Two or more pipes opening into the same chimney should have *separate flues*; when they open into the same flue, the pipe that draws best will interfere with the draught in the others, and set up downward currents.

The air consumed by combustion escapes by the chimney, and tends to create a vacuum in the room; but it is steadily replaced by the atmosphere which rushes in at every available opening. This rush is strongest at the lowest openings (those nearest the earth), and here the whole amount enters if the space is sufficient. On the other hand, and for the reasons before given, the warmer (lighter) and fouled air within has a constant tendency to escape at the highest points; and it is here, therefore, that ventilators should be placed to allow its exit. Thus it is that, when a door is opened, the warmer (foul) air escapes in a current at the top, and the colder (fresh) from the outside rushes in at the bottom. This may be shown by a lighted taper in these situations—the flame in each case taking the direction of the current. When the outside air is the warmer, and per consequence the lighter, as on a very warm summer day, the direction of the currents, other things being the same, will be reversed—the fresh air coming in above, and the cool air within escaping below. But, owing to the large amount of heat radiated from the pupils—the normal temperature of the human body averaging 37.5° Cent., or 99° Fahr.—the lighter air is nearly always within. Therefore, if on the sheltered side a window is lowered at the top, or on any side if the air be calm, the foul air will escape above it; if raised from below, fresh air will enter beneath. But, ordinarily, it is sufficient to fully provide for the escape of the fouled air—the fresh, as a rule, will not need so much attention; yet it is better to make ample provision also for this. The best method is by ventilators in the walls—say of a foot square in section, or thereabout—raised but a few inches above the floor below, and lowered but a few inches below the ceiling above; or otherwise at the highest points of the ceiling itself. In this way the currents that are likely to blow on the children's shoulders when the windows are raised are avoided, a matter of importance; for a draught of cold air blowing upon the shoulders *from behind*, arrests the action of the skin — probably through the spinal sensory nerves—and causes what is commonly known as a "cold." Even when windows are lowered at the top, draughts will occasionally blow upon the pupils; and the lower the windows are set in the wall, the stronger and more uncomfortable and injurious is the draught. In order to prevent these draughts, the windows should be set

high in the wall and lowered on the sheltered side whenever possible. An ingenious contrivance for the prevention of draughts through open windows has been suggested by Dr. Swinburne, in a paper read before the last annual meeting of the New York State Medical Society. It consists in the attachment of one end of a strip of unstarched muslin to a spring roller fastened to the casement above, and the other end to the upper edge of the window itself. On lowering the window, the muslin is unrolled and thus stretches across the vacant space. Being held tense by the spring of the roller, it effectually shuts off all draught, while it allows the escape of the foul gases within, and the slow but steady entrance of fresh air.

Even should there be no currents through ventilators or open windows, yet the foul gases will make their escape by *diffusion;* for, according to the law of diffusion, there is a rapid interchange between gases in free communication. Of course the outflow of the inside air very materially hastens the rapidity of the interchange; but the outflow will not, can not, be very rapid if there is not sufficient provision for the entrance of fresh air other than through the same apertures through which the outflow itself takes place. Again, the warmer the day, the less the difference between the temperature of the inside and the outside air; hence, the buoyancy of the inside air is less, and consequently the ventilation is not so effective; so that more attention and greater facilities must be afforded it. Ventilators should never be placed in the hall; here they do but little good. The doors leading from the hall to the rooms are usually closed, and, even if open, the buoyancy of the air as a factor in ventilation is nearly eliminated; for there is a partition between the hall and the room, so that the light air and the lighter animal exhalations would be compelled to descend to the level of the top of the communicating door in order to escape. This they cannot do for it is in opposition to gravity. If no other outlet is provided, the only ventilation will be by diffusion through the doorway with the purer air in the hall. The animal exhalations will fill the room from the ceiling to the level of the top of the communicating door, and there remain. It would cost but a trifle to have one or two ventilators put in the ceiling of a school-room where there are none in the walls; and school directors could not make a better investment of the money. Children will not study, and cannot be persuaded or compelled to study diligently, in the foul and stifling air of a crowded and wretchedly ventilated room. It may be safely asserted that in a majority of our schools the ventilation is insufficient, or not properly attended to, either on account of lack of knowledge or attention on the part of the teacher, or the defective construction of the building. A sanitary inspection should be made of every school in the State by a competent medical inspector; and all the schools found defective in this (or any other way injurious to health) should have all such defects remedied, or otherwise be condemned as unfit for school purposes, with the imposition of penalties for using them as such.

A school-room should have a high ceiling; contain from two hundred to three hundred cubic feet of air to each pupil; have one or more ventilators in the ceiling, or the walls near the ceiling; have long, high windows arranged to slide upward from beneath and downward from above. All the children should be sent out at recess, if only for a short time, in order to have their clothing—saturated as it usually is by animal exhalations—exposed to the purifying influence of the open air, and doors and windows thrown open in order to completely change the air within. Stoves, chimneys, pipes, etc., should be carefully looked after, and any accident or defect promptly attend-

ed to, or immediately reported. Children convalescing from contagious diseases should be excluded from school for weeks, or months, according to the recognized limit of contagiousness of the disease. It should not be forgotten that the school and church are the two great centres for the communication of contagious diseases; and that both are active in this way in direct proportion to the insufficiency of the ventilation.—*Dr. Higgins in Pop. Science Monthly.*

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## ENGLISH DEPARTMENT.

### EXAMINATION OF TEACHERS FOR FIRST-CLASS CERTIFICATES.

*Grade G.*

ENGLISH GRAMMAR.

1. *Cor.* Shall remain!
Hear you this Triton of the minnows? mark you
His absolute *shall?*
*Com.* 'Twas from the canon.
*Cor.* *shall!*
O good, but most unwise patricians, why,
You grave, but reckless, senators, have you thus
Given Hydra here to choose an officer,
That with his peremptory *shall*, being but
The horn and noise o' the monsters, wants not spirit
To say he'll turn your current in a ditch,
And make your channel his? If he have power,
Then vail your ignorance: if none, awake
Your dangerous lenity. If you are learned,
Be not as common fools; if you are not,
Let them have cushions by you. You are plebeians,
If they be senators; and they are no less,
When, both your voices blended, the greatest taste
Most palates theirs. They choose their magistrate;
And such a one as he, who puts his *shall*,
His popular *shall* against a graver bench,
Than ever frown'd in Greece! By Jove himself,
It makes the consuls base! and my soul aches
To know, when two authorities are up,
Neither supreme, how soon confusion
May enter 'twixt the gap of both, and take
The one by the other.

—*Coriolanus, Act iii, scene 1.*

(i.) Parse *Hydra here to choose*, l. 10; *with*, *being but*, l. 11: *horn*, l. 12; *to say*, l. 14; *channel his*, l. 15; *voices*, *taste*, ll. 23, 24; *theirs*, l. 25; *By*, l. 29; *It*, l. 31; *To know*, l. 33: *Neither*, l. 34.

(ii.) Analyse fully from "They choose their magistrate," l. 25, to "Greece," l. 29.

(iii.) Explain the force of *with*, l. 11.

(iv.) *He'll turn your current in a ditch*, *And make your channel his*, ll. 14 and 15. Between whom is a comparison made in these words?

(v.) Scan ll. 8 and 12.

(vi) Derive *absolute*, *officer*, *spirit*, *current*, *power*, *neither*, *betwixt*, *other*, *then*, *than*, *when*, *such*.

2. Distinguish, according to Mason, between verbs of complete and verbs of incomplete predication. Criticise his views on this subject.

3. Give a full account of the functions of words ending in *ing*.

4. Distinguish the different sounds represented by the letter *e* in the English language, exemplifying each by giving at least three words in which it occurs.

5. Correct the following selections:

"Some teach the alphabet at the first before teaching the pupils to read. By doing this it makes the pupils dull as it will take considerable in teaching them representatives of something they know nothing of, whereas if the word is taken as a whole, being a representative of something that pupils are familiar with, for instance if the pupil is told that OX stands for ox, they will quite easily remember this for they are quite familiar with the animal called 'ox' and this is represented by the word 'ox.'

"When the child starts first to read he ought not to be taught that OX is *ox* because the letters OX spell ox; he will learn the spelling accidentally with the reading; but he ought to have a picture of an ox shown him and then told that the word 'ox' is ox, he will remember this like he does the picture, because it is but a picture of a word.

"This method I consider a very poor one as a child knows a great many words before it comes to school and wants to be taught the formation of these words, that is going so far from the known to the unknown and then breaking up the word into its parts is again a second step from the known to the unknown, while the method stated is beginning with an unknown leading them in the dark to, perhaps, a known, or perhaps an unknown."

6. "In this point charge him home, that he affects
Tyrannical power. If he evade us there,
Enforce him with his envy to the people
And that the spoil got from the Antiates,
Was ne'er distributed."

(i.) Analyze fully
(ii.) Parse "home."

7. Accentuate *exorcist*, *clematis*.

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*Answers to paper in English Grammar.*

(i.) *Hydra* is a proper noun of the mas. gender, singular number, third person, and in the objective case being the indirect object of the verb 'have given.'

*Here* is an adverb of place; from the omission of an adjective or participle, it is now in the attributive relation to Hydra.

*To Choose* is a verb, transitive, of the strong conjugation, active voice, and in the present indefinite tense, of the infinitive mood, depending on the verb 'have given,' of which it is the direct object.

*With* is a preposition showing the relation between the relative pronoun 'that,' and the noun 'shall.'

*Being* is the imperfect participle of the verb 'to be,' and it is in the attributive relation to the relative pronoun 'that.'

*But* is an adverb modifying the nouns following, because they are used predicatively: see Mason, section 374.

*Horn* is a common noun of the neuter gender, singular number, third person, and in the nominative case, being the predicate nominative after 'being.'

*To say* is a verb, transitive, of the weak conjugation, active voice, and in the present indefinite tense, of the infinitive mood used adverbially, modifying the verb 'wants.' It is an example of what is sometimes called the gerundial infinitive.

*Channel* is a common noun of the neuter gender, singular number, third person, and in the objective case governed by the verb 'make.'

*His* is a possessive pronoun of the masculine gender, singular number, third person and in the objective case, being the objective complement of the verb 'make.'

*Voices* is a common noun of the neuter gender, plural number, third person, and in the nominative case used absolutely.

*Taste* is a common noun of the neuter gender, singular number, third person, and in the nominative case, being the subject of the verb 'palates.'

*Theirs* is a possessive pronoun of the masc. gender, plural number, third person, and in the objective case governed by the verb 'palates.'

*By* is a preposition showing the relation between the noun 'Jove' and some verb understood.

*It* is a demonstrative pronoun of the neuter gender, singular number, third person, and in the nominative case, being the subject of the verb 'makes.'

*To know* is a verb, transitive, of the strong conjugation, active voice, and in the present indefinite tense, of the infinitive mood used adverbially, modifying 'aches.'

*Neither* is a distributive pronoun of the masc. gender, singular number, third person, and in the nominative case used absolutely.

(ii.) Sentence for analysis: "They choose their magistrate."

Kind—Principal declarative.

Subject—They.

Predicate Simple—Choose.

Object—Magistrate.

Attribute of object—Their.

Sentence: "(They choose) such a one."

Kind—Principal declarative.

Subject—They (understood).

Pred. simple—Choose (understood.)

Object—One.

Attribute of Object—Such a.

Sentence: "As he (is)."

Kind—Subordinate adjectival, coordinate with such.

S.—He.

Pred. complex, verb of I. P.—Is.

Complement—As. As is regarded as a relative pronoun after the word "such."

Sentence: "Who puts his *shall*, his popular *shall* against a graver bench."

Kind—Subordinate adjectival, qualifying "he."

S.—Who.

Pred. simple—puts.

O.—shall.

Attributes of O—His, his popular *shall*.

Adverbial adjuncts to verb—Against a graver bench.

Sentence: "Than ever frowned in Greece." Supply as follows:—Than that bench is grave which ever frowned in Greece.

First proposition: "Than that bench is grave."

Kind—Subordinate adverbial, modifying "graver."

S.—That bench.

Pred. complex—Is grave.

Second proposition: "Which ever frowned in Greece."

Kind—Subordinate adjectival qualifying 'bench.'

S.—Which.

Pred. simple—Frowned.

Adverbial adjuncts to pred—Ever, in Greece.

(iii.) With (Mason Section 248) here appears to denote *attendant circumstances.*

(iv.) Between Sicinius and Triton.

(v.) In the scansion of line 8, *o'the* is to be pronounced as a monosyllable, and *spirit* is to be regarded as another monosyllable; see Shakesperian grammar (Abbott) section 463.

In line 12, the letter *e* of dangerous is slurred over so that the word becomes a dissyllable. *Learned* can be treated as a monosyllable in the same way as the participle is pronounced at present.

(vi.) For the derivation of these words consult Chambers' Etymological Dictionary.

2. See Mason's Grammar, section 391.

Transitive verbs do not of themselves make a complete statement about their subject, they require to be completed by their objects to do so, so that there is no good reason why all transitive verbs should not be treated strictly as verbs of incomplete predication. From the foregoing it is seen that Mr. Mason's classification is arbitrary, it is not the less useful, however, as it points out more clearly than any other system the force of the complement of

the verb, though it does not disclose any new power in the verb itself.

For example take the sentences "He painted the house" and "He painted the house white." The peculiar force of the word "white" is more clearly brought out by attaching it with the verb in the predicate, and thus the difference between its use in a sentence such as the above, and in the sentence "He painted the white house" is readily apprehended, but the verb 'painted' has the same force in both sentences.

We conclude that Mr. Mason's classification is illogical or arbitrary, but, nevertheless, useful.

3. See Angus's hand-book, sections 285 to 289.

4. See Angus's hand-book, section 106.

5. These selections can be amended in a great variety of methods; we only suggest one without claiming that it is the only one.

(i.) Some teach the alphabet as the first step in teaching the pupils to read. By doing this they confuse the pupils in trying to teach them the representatives of things which they know nothing of; whereas, if the words are taken as wholes, as representatives of things with which the pupils are already familiar they will the more readily learn to read them.

If the pupils are told, for instance, that the printed word 'ox' stands for ox, they will easily remember it, for they are quite familiar with the animal called 'ox' which is represented by the word 'ox.'

(ii.) When the child begins to read he should not be taught that the printed word 'ox' is ox because the letters o, x, spell the word ox, for he can learn the spelling incidentally with the reading; but he should be shown the picture of an ox and then told that the printed word 'ox' stands for the name (or spoken word) 'ox.' He will remember the printed word in the same way as he remembers the picture, for the former is but the picture of the name.

(iii.) This method I consider a very poor one, as it leads pupils from an unknown to a known, or perhaps to to what is still unknown. As a child knows a great many words before coming to school, he should be taught the printed form of these words; so far this would be proceeding from the known to the unknown; next he should be taught to notice the parts of these words; this again would be a step from the known to the unknown.

6. (i.) Sentence to be analyzed: "In this point charge him home."

Kind—Principal imperative.

S.—You (understood)

Pred. simple—Charge.

Object—Him.

Adv. adjuncts of pred.—In this point, home.

Sentence: "That he affects tyrannical power."

Kind—Noun sentence used adverbially, modifying "charge."

S.—He.

Pred. simple—Affects.

O.—Power.

Attribute of O.—Tyrannical.

Sentence: "If he evade us there."

Kind—Subordinate adverbial, modifying "enforce."

S.—He.

Pred. simple—Evade.

O.—Us.

Adv. adjunct of pred.—There.

Sentence: "Enforce him with his envy to the people."

Kind—Principal imperative.

S.—You (understood.)

Pred. simple—Enforce.

O.—Him.

Adv. adj.—With his envy to the people.

Sentence: "That the spoil got from the Antiates was ne'er distributed."

Kind—Noun sentence used adverbially, modifying 'enforce.'

S.—Spoil.

Attributes of S.—The, got from the Antiates.

Pred. simple—Was distributed.

Adv. adj. of pred.—Ne'er.

(ii.) *Home* is an adverb of manner, modifying the verb "charge."

7. Exorcist, clématis.

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## EXAMINATION PAPER IN ENGLISH ANSWERED.

*Second Class Teachers and Intermediate, July, 1880.*

### ENGLISH GRAMMAR.

1. "—— In vain,
Opinions, those or these,
Unaltered to retain
The obstinate mind decrees,
Experience, like a sea, soaks, all effacing, in."

"—— Who lists
May what is false hold dear,
And for himself make mists
Through which to see less clear;
The world is what it is, for all our dust and din."

*Matthew Arnold—Empedocles on Ætna.*

(i.) Parse the words in the second and fifth lines.

(ii.) Analyze fully the second stanza.

(iii.) State the meaning in other words.

(i.) *Opinions* is a common noun of the neuter gender, third person, sing. number, and in the objective case, being governed by *to retain.*

*Those* is a demonstrative adjective in the attributive relation qualifying the noun *opinions.*

*Or* is a co-ordinative and alternative conjunction connecting the sentences to which *those* and *these* belong.

*These* is a demonstrative adjective in the attributive relation qualifying *opinions.*

*Experience* is an abstract noun of the neuter gender, third person, sing. number, and in the nom. case, being the subject of the verb *soaks.*

*Like* is an adverb of manner, without comparison, modifying the verb *soaks.*

*Soaks* is an intransitive verb of the weak conjugation, active voice, indicative mood, present indefinite tense, in the third person and sing. number to agree with its subject, *experience.*

*All-effacing* is a compound qualitative adjective in the attributive relation qualifying *experience.*

*In* is a simple adverb of manner modifying the verb *soaks.*

(ii.) Sentence: "Who lists."

Kind—Subordinate adjectival qualifying *he* understood.

Subject—*Who.*

Simple predicate—Lists.

Sentence: "May what is false hold dear."

Kind—Principal declarative.

Sub.—*He* understood.

Predicate complex, verb of I. P:—*May.*

Complement of V. of I. P.—*Hold.*

Secondary Complement—*Dear.*

Object of C—What is dear.

Sentence: "What is dear."

Kind—Substantive object of *hold.*

S—'What.'

Predicate complex—"is dear."

Sentence: "For himself make mists through which to see less clear."

Kind—Principal declarative.

S—*He* understood.

Predicate complex—'may make.'

Adverbial adjuncts of C—'For himself,' "through which to see less clear."

Sentence: "The world is what it is, for all our dust and din."

Kind—Principal declarative.

S—'World.'

Attribute of S—'the.'

Predicate complex V. of I. P.—'is.'

Complement—"What it is."

Adverbial adjunct of V. of I. P.—"For all our dust and din."

(iii.) It is useless for the prejudiced mind to endeavor to maintain rigidly its preconceived notions; it is compelled to modify its views by the light of experience.

A man may, if he pleases, cherish a

belief in what is false and by casuistry maintain himself in this belief; yet, notwithstanding all such attempts to obscure the truth, we cannot change the real state of affairs in the world around us.

2. Correct anything which is wrong in the following sentences, giving your reason in each case:—

*(a)* "She wrote, among other poems, a spirited defence of her sex, in answer to Pope's 'Character of Women,' which Duncombe praises in his Feminead."

The antecedent of *which* is ambiguous; a rearrangement of clauses is therefore necessary.

"Among other poems, she wrote, in answer to Pope's 'Character of Women,' a spirited defence of her sex, which Duncombe praises in his Feminead."

*(b)* "It is surprising how a great part of life is made up of trifles."

This is not the assertion intended to be made. What is surprising is not the way in which a great part of life is made up of trifles, but the magnitude of the part; hence, the sentence should read "how great a, &c."

*(c)* "Religion is surely to be taught, but what of it is to be taught, and how?"

This sentence should read "how is it to be taught." For reason see section 446, Mason.

*(d)* "The way and manner of doing it is certainly, as it seems to me, very evident and plain, and easy to be understood and comprehended."

This sentence has the fault of tautology; it may be amended thus:—"The manner of doing it is certainly, as it seems to me, easy to be understood."

*(e)* "The English hate frogs, but the French love frogs, and hate the English, and cut off their hind legs, and consider them a great delicacy."

The sentence is ambiguous and inelegant on account of the misplacing of a clause, and the compound structure of the latter part of it. The verb *love* is not usually employed in this acceptation by good writers. It should read as follows: "The English hate frogs, but the French, who hate the English, like frogs, and cut off their hind legs which they consider a great delicacy."

*(f)* "Hear what the senior professor of the Dublin Normal says about it."

"Dublin Normal" is too colloquial an expression, supply the word 'school' after it; otherwise the sentence may be regarded as correct.

*(g)* "This being comparatively slow and opposite of flashy, has not obtained the reward given to the charlatan."

The first clause is evidently an absolute one giving a reason for the principal assertion, and consequently 'this' should not be regarded as the subject of the verb. 'This' also refers to something inanimate and there would be an incongruity in comparing it with reference to its reward, to a person, to a charlatan. Correction: "This being comparatively slow and the opposite of flashy, it has not obtained the reward given to charlatanism."

3. *(a)* Point out the ambiguity in each of the following sentences:—

"They have no more control over him than others."

This may mean that they have no more control over him than they have over others, or no more control than others have over him.

*(b)* "Rich or poor, you have always been to me a true friend."

The words "rich or poor" may apply to 'you' or 'me.'

*(c)* "His presence was against him."

This may mean that his appearance was against him, or the fact that he was present was against him.

*(d)* "A man who has lost his eyesight has, in one sense, less consciousness than he had before."

'In one sense' may be understood to refer to one of the five senses, or as equivalent to an ordinary adverbial phrase such as "in a measure."

*(e)* "The connection between words and ideas is arbitrary and conventional

owing to the agreement of men among themselves."

This may refer to the connection existing between ideas and the words which represent them, or it may refer to the connection between words themselves and to the connection between ideas considered apart from the words that represent them.

4. Punctuate the following sentence in two ways:—

Richard Green Parker says James Russell Lowell is a great genius.

Richard Green Parker says "James Russell Lowell is a great genius."

"Richard Green Parker," says James Russell Lowell, "is a great genius."

5. Accentuate *vehemently*, *vagary*, *laboratory*.

*Vē-he-ment-ly*, *va-gā-ry*, *lăb-o-ra-to-ry*.

6. Parse the italicized words in the following sentences:—

(*a*) They were all rescued *to* a man.

(*b*) I *had rather be* a *door-keeper* in the house of the Lord *than dwell* in the tents of wickedness.

(*c*) These documents prove my title *good*.

(*d*) He falls like Lucifer, never *to hope* again.

(*e*) Music hath charms *to soothe* the savage breast.

(*f*) *Once upon* a time there lived a prince.

*To* is a preposition showing the relation between the noun *man*, and the verb *were rescued*.

*Had* is a verb transitive, of the irregular weak conjugation, in the subjunctive mood, and past indefinite tense, of the first person and singular number agreeing with its subject I.

*Rather;* according to Mason this word is to be regarded a qualitative adjective in the comparative degree forming the complement of the verb *had*, and qualifying the infinitive *be*.

*Be* is a verb, intransitive, irreg. strong conjugation, in the present indefinite tense, of the infinitive mood, the object of the verb *had*.

*Door-keeper* is a noun common, of the masculine gender, third person and singular number, and in the nominative case, being the predicate nominative after *be*.

*Than* is an adverbial conjunction, connecting the sentence following with the preceding one, and modifying a verb understood (would).

*Dwell* is verb, intransitive, of the weak conjugation, and in the present indefinite tense, of the infinitive mood, depending on a verb understood. The ellipsis may be supplied thus: than I would soon dwell, &c.

*Good* is a qualitative adjective in the positive degree, qualifying the noun title, and forming the complement of the verb *prove*.

*To hope* is a verb, intransitive, of the weak conjugation, and in the present indefinite tense, of the infinitive mood used adverbially, modifying the verb *falls*.

*To soothe* is a verb, transitive, of the weak conjugation, and in the present indefinite tense, of the infinitive mood, used as an adjective qualifying the noun *charm*.

*Once* an adverb of time, without comparison, modifying the verb *lived*.

*Upon* is a preposition showing the relation between the noun *time* and the verb *lived*.

7. Explain what you mean by inflexion. Give examples of all the inflexions of the language.

Inflection is a change in the form of a word to indicate a change in its meaning, or in its relation to other words.

For the latter part of the question consult any text book.

8. State which of the following expressions is correct, giving your reasons:—

(*a*) The { passing / passage } of the bill.

The preferable expression here is the passage &c.

The termination *ing* directs special

attention to action or is of active significance, and the *age* is of passive force. The term passage is, therefore, better suited to denote the lengthy process through which a bill is put before it becomes law.

*(b)* I differ { from / with } you.

We differ *with* a person and *from* an opinion; hence according to usage the sentence should read, "I differ with you."

*(c)* The honor { bestowed / conferred } on me.

From usage it should be "the honor conferred, &c."

*(d)* Such expressions sound { harsh. / harshly. }

The quality of the subject is here referred to as seen in or during the action indicated by the verb, and not the manner of the action; hence the adjective harsh should be used.

*(e)* { Whom / Who } do you say that I am.

Who should be used here since the pronoun is in the nominative case after am.

*(f)* It is a long time since I { have been / was } devoted to your interest.

*Since* makes the time distinctly past, hence the verb should be *was* and not *have been*, which would refer to present as well as past time.

*(g)* As two { is / are } to four, so { is / are } four to eight.

*Two* and *four* must be here regarded as abstract terms and as such are singular, hence the singular verb should be employed.

*(h)* It is better to fall among vultures than flatterers, for { those / these } devour only the dead { those / these } the living.

The correct expression is "Those devour only the dead, these, &c." 'Those' should be used to refer to what is first mentioned.

*(i)* Less than a million tons { are / is } produced in a year.

The correct verb is 'is.' By using 'less,' reference is made to quantity and not number, hence the verb should be singular.

*(j)* The temper as well as the knowledge of a modern historian { require / requires } a more sober and accurate style.

The verb should be singular, as it agrees only with the first subject.

*(k)* In reality more than one principle { has / have } been contended for.

The subject of the verb is plural (more principles than one, &c.,) and consequently the verb should be plural.

*(l)* The following is the mode of { proceeding / procedure } in such a case.

The word 'procedure' may itself mean mode of proceeding, hence "mode of proceeding" is to be preferred.

9. What is the difference in meaning between:—

| | | |
|---|---|---|
| A king of France | and | a French king? |
| A serial story | " | a serious story? |
| Politic | " | political? |
| Practical | " | practicable? |
| An age of faith | " | an age of credit? |
| The silent man | " | the taciturn man? |
| Ingenious | " | ingenuous? |
| Conciliate | " | reconcile? |

Consult any dictionary of English synonyms, such as Crabb's.

10. Criticise the following definitions:—

A verb is a word which may be used as the predicate in a sentence without a copula.

According to Mason the grammatical copula consists of the personal inflections of the verb. This meaning of the term copula is not evidently the one

intended, as the definition would then be nonsensical. The term copula is here used as it is in logic to refer to the verb 'to be' or some verb denoting existence. If in the latter sense the definition would not be at all applicable to what are called verbs of incomplete predication, as in the sentence "The rose smells sweet;" here, there is no copula, and yet the verb does not constitute the predicate but only part of it.

11. Give the roots of *altitude, city, recluse, deign, hypothesis, autocrat, phrase, school, boon, call, claim, chief.*

Consult Chamber's Etymological dictionary.

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## MATHEMATICS.

*Solution to Algebra Paper in June number, page 178.*

2. (1). $2+2-5+4+0-9$

$$\begin{array}{r|l|l} & & 3 \\ \hline 3 & 6+6 & -15+12+0-27 \\ -3 & -6 & \\ 10 & & 20 \\ 1 & & 2 \\ -3 & & -6 \\ \hline & 2\ 0 & 5+14\ -6-27 \end{array}$$

$$3+3-10-1+3$$

$$\begin{array}{r|l|l} & & 5 \\ \hline 5 & 15+15 & -50-5+15 \\ -14 & -42 & 75.6 \\ 6 & & 18-32.4 \\ 27 & & 31-145.8 \\ \hline & 3-5.4 & 43.6+43.6-130.8 \end{array}$$

$$\begin{array}{r|l|l} & & 5 \\ \hline 218 & 218 & +218-654 \\ & 1 & +1-3 \end{array}$$

$$\begin{array}{r|l|l} 1 & 5+14 & -6-27 \\ -1 & -5 & -9 \\ 3 & & 15+27 \\ \hline & 5+9 & \end{array}$$

$\therefore x^2+x-3$ is the G. C. M.

(2)

$$\begin{array}{r|l} & 4-11 \\ \hline 5 & 20+45+105+255 \\ -6 & -24-54-125-306 \\ \hline & 4+9+21+51+129+\&c. \end{array}$$

$=4+9x+21x^2+51x^3+129x^4+\ldots$

To show that the coef. of $x^n$ is $3^n + 3.2^n$.

If we put $n=0, 1, 2, \ldots$ we obtain $4, 9, 21, \ldots$

Now, suppose this holds up to $x^r$, then we should have

$$\begin{array}{l|l} 3^{r-1}+1 & 5.2^{r-1}, \quad 5.3^r+15.2^r \\ -6.3^{r-2}-18.2^{r-2}, & -6.3^{r-1}-18.2^{r-1} \\ \hline 3^r+3.2^r, & 3^{r+1}+3.2^{r+1} \end{array}$$

$\therefore$ if this law holds up to $x^r$ it holds for $x^{r+}$ and it has been shown to hold for $x, x^2, \ldots$ $\therefore$ it holds generally.

In adding $5.3^r + 15.2^r$ and $-6.3^{r-1} - 18.2^{r-1}$, notice that

$$5.3^r - 6.3^{r-1} = 5.3^r - 2.3^r = 3.3^r = 3^{r+1}$$

and that $15.2^r - 18.2^{r-1} = 15.2^r - 9.2^r = 6.2^r = 3.2^{r+1}$.

(3)

$$\begin{array}{r|l|l|l} & 1+p_1+p_2 & & +p_3 \\ a & a & a(p_1+a) & a^3+a^2p_1+ap_2 \\ \hline & 1, p_1+a, & a^2+ap_1+p_2 & \end{array}$$

From this it is evident that the remainder is $a^n + p_1 a^{n-1} + \ldots\ldots + p_n$.

3. (1). $apx^2 + (aq+bp)x + bq$
$= (ax+b)(px+q)$
$aqx^2 - (ap-bq)x - bp$
$= (ax+b)(qx-p)$

$\therefore (ax+b)(px+q)(qx-p)$ is L. C. M.

(2) $xy(x^2 - y^2)$

(3) G. C. M. $= ab^{p-2}c^q$
L. C. M. $= a^{r+2}b^p c^{2q}$

4. See Hamblin Smith's Algebra, p. 18, and Wood's Algebra, p. 18, 52, 91,

5. $$\frac{\sqrt{7}-2}{\sqrt{11+\sqrt{112}}} = \frac{\sqrt{7}-2}{\sqrt{7}+2}$$

$$= \frac{(\sqrt{7}-2)(\sqrt{7}-2)}{(\sqrt{7}+2)(\sqrt{7}-2)} = \frac{11-4\sqrt{7}}{3} = \&c.$$

7. (1) $x = 11a$

(2) $x = 5$ or $\pm\sqrt{7}$

(3) $x = 5$

(4) $x^2y - x^2 + 3x^2y - 3y = \sqrt{x^2 + 3y}$

$\therefore x^2 + 3y + \sqrt{x^2 + 3y} = 4x^2y = 20.$

$\therefore \sqrt{x^2 + 3y} = 4$, or $-5$,

$\therefore x^2 + 3y = 16$, or $25$.

Also, $x^2y = 5$, $\therefore x^2 = \frac{5}{y}$

$\therefore \frac{5}{y} + 3y = 16$,

$\therefore y = 5$ or $\frac{1}{3}$,

and $x^2 = 1$ or $15$.

8. Let $x$ = the length of the side of the base,

$y$ = " height of the pyramid,

$z$ = " " " part cut off.

then the vol. of pyr. $= \frac{1}{3}x^2y$

vol. of upper pyr. $= \frac{1}{3}x^2y \times \frac{z^3}{y^3}$

$\therefore$ vol. of lower part $= \frac{1}{3}\frac{x^2}{y^2}(y^3 - z^3)$

also from (1) this vol. $= \frac{1}{3}x^2(y - 6\frac{3}{7})$

" (2) " $= \frac{7}{12}x^2(y - z)$

" (3) " $= 15^3$

Hence we have three equations

$$\frac{1}{2}\frac{x^2}{y^2}(y^3 - z^3) = 15^3 \quad .. (1)$$

$$\frac{1}{3}x^2(y - 6\tfrac{3}{7}) = 15^3 \quad .. (2)$$

$$\frac{7}{12}x^2(y - z) = 15^3 \quad .. (3)$$

to determine $x$, $y$ and $z$.

Dividing (1) by (3) we have

$3y^2 - 4yz - 4z^2 = 0$

$\therefore (y - 2z)(3y + 2z) = 0$

$\therefore y = 2z$

Substituting for $z$ in (3) we get

$7x^2y = 24 \times 15^3$ while from (2) we have $7x^2y = 45x^2 + 21 \times 15^3$

$\therefore 45x^2 = 3 \times 15^3$

$\therefore x = 15$

$\therefore y = 5\frac{13}{7}$

Also since $y = 2z$, the height of the upper pyr. is one-half that of the whole pyr. $\therefore$ its vol. is one-eighth of the whole *i. e.* one-seventh of the lower part *i. e.* $\frac{1}{7}$ of $15^3$ or $482\frac{1}{7}$ cubic feet.

9. Let $a, b$; $c, d$; $e, f$; $g, h$ be the four pairs of quantities, then

$$\frac{c}{d} = \frac{ae}{bf} \text{ and } \frac{e}{f} = \frac{cg}{dh}$$

$$\therefore \frac{c}{d} = \frac{acg}{bdh}$$

$$\therefore 1 = \frac{ag}{bh} \quad \therefore \frac{a}{b} = \frac{h}{g}$$

10. Let $a = pd^2$, $b^3 = m^3d^4$, $c^3 = \frac{n^3}{d}$

$\therefore a^3b^3c^3 = p^3m^3n^3d^9$

$\therefore abc = pmnd^3$

$\therefore abc$ varies as $d^3$

And if we had supposed $a, b$ and $c$ each to vary as $d$ the same result would have been obtained.

11. The sum of $n$ consecutive odd numbers beginning with $2m + 1$ is

$$(2\overline{2m+1} + 2\overline{n-1})\frac{n}{2}$$

which $= 2mn + n^2$

But $n^2$ is the sum of the first $n$ odd numbers $\therefore$ this sum is greater than the sum of the first $n$ odd numbers by $2mn$.

12. Let $b = a + d$ then $d$ is small compared with $a$ or $b$. The difference between the Arithmetic and the Harmonic mean is

$$\frac{1}{2}(2a + d) - \frac{2a(a + d)}{2a + d}$$

which $= \frac{d^2}{4a + 2d}$

And this is small compared with $d$. Also since the G. mean lies between the Arith. and Har. means $\therefore$ *a fortiori* the difference between $A$ and $G$, or between $G$ and $H$ is small compared with $h$.

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## SOLUTIONS TO PROBLEMS FROM CORRESPONDENTS.

1. Required, the greatest possible number of hills of corn that can be planted on a square acre of ground, no two hills to be nearer than

three and a-half feet from centre to centre.

The side of a square acre is 208·7 feet, and therefore, one row across would contain 60 hills and leave a space of more than two feet between the last hill and the side of the field; so that if the second row is arranged, with reference to the first, thus:

* * * * *
* * * * * *

there will be room in the second row for 60 hills also. Again, since these two rows are $1{\cdot}75 \times \sqrt{3}$ feet apart, the acre may contain 69 of these rows. There may, therefore, be at least $69 \times 60 = 4140$ trees.

2. A man has a circular garden, ten rods in diameter; how many trees can be set in it, so that no two will be within ten feet of each other, and no tree within two feet and a-half of the fence enclosing the garden?

A method somewhat similar to that in No. 1 will give 241 as the number.

3. Solve the equation:

$$(1+x)^{\frac{2}{n}} - (1-x)^{\frac{2}{n}} = (1-x^2)^{\frac{1}{n}}$$

Put $y$ for $(1+x)^{\frac{1}{n}}$

" $z$ " $(1-x)^{\frac{1}{n}}$

then the equation becomes

$$y^2 - z^2 = yz$$

$$\therefore \frac{y}{z} = \frac{1}{2}(1 \pm \sqrt{5})$$

$$= k \text{ suppose}$$

$$\therefore \left(\frac{1+x}{1-x}\right)^{\frac{1}{n}} = k$$

$$\therefore \frac{1+x}{1-x} = k^n$$

$$\therefore x = \frac{k^n - 1}{k^n + 1}$$

$$= \frac{(1 \pm \sqrt{5})^n - 2^n}{(1 \pm \sqrt{5})^n + 2^n}$$

## ARITHMETIC.

*(First Class—Grade C.)*

1. Examine the merits of the following test of the accuracy of a sum in addition: "Divide the sum of the digits in each horizontal line by 9, retaining only the remainders; divide the sum of these remainders by 9, and if the remainder then obtained be equal to the remainder obtained on dividing the sum of the digits in the answer by 9, the answer is correct."

Will the test apply if "vertical lines" replace "horizontal lines" in the preceding, and if so, why?

Suppose the first horizontal line to contain $9a$ times, with remainder $p$ (which will also be the remainder on dividing the sum of the digits in the first line by 9); the second to contain $9b$ times, with remainder $q$; the third $c$ times, with remainder $r$, &c., then

the first line $= 9a + p$
" second " $= 9b + q$
" third " $= 9c + r$
&c.

$\therefore$ the whole sum
$= 9(a + b + c + \&c.) + p + q + r + \&c.$

Let $p + q + r +$ &c. contain $9m$ times, with remainder $n$, then the whole sum
$= 9(a + b + c + \&c. + m) + n$
that is, the whole sum on being divided by 9 has remainder $n$ also, so that if the answer is correct the remainders must be the same, and therefore, if the remainders are not the same the answer cannot be correct; but it does not necessarily follow that if the remainders are the same the answer is correct, for it is evident that the sum of the digits in the answer, on dividing by 9, will leave the same remainder in whatever order the digits be taken, and also that this remainder will not be affected by any number of 9's, too many or too few, in the answer.

Next, suppose the first vertical line to the right to contain $9, a$ times, with remainder $p$; the second $b$ times, with remainder $q$, &c.

$\therefore$ the first line $= 9a + p$,
second $= (9b + q) \times 10.$
$= 90b + 10q.$

And since any number when multiplied by a power of 10 leaves the same remainder as the number itself on dividing by 9, $\therefore$ the actual

remainder in the second column is $q$, in the third $r$, &c.. and the same conclusions are reached as in the first case.

2. A man sells goods for \$1125. Half he sold at an advance of 25 per cent. on the cost, two-fifths at an advance of $12\frac{1}{2}$ per cent., and the remainder at half its cost. What did he originally pay for the goods ?

A gain of 25 per cent. on half is equal to a gain of $12\frac{1}{2}$ per cent. on the whole; $12\frac{1}{2}$ on two-fifths to 5 on the whole, and a loss of 50 per cent. on one-tenth, to a loss of 5 per cent. on the whole, $\therefore$ these are equivalent to a gain of $12\frac{1}{2}$ per cent. or one-eighth, $\therefore$ the cost is $\frac{8}{9}$ of 1125, or \$1000.

3. If 4 pumps, each having a length of stroke of 3 feet, and piston of radius 3 inches empty a cubical cistern whose side is 6 feet, in one hour. What must be the radius of the piston of each of 6 pumps whose stroke is 4 feet, that they may empty a cistern whose sides are half those of the former, in five-eighths of an hour, there being a defect in the latter pumps which takes away 10 per cent. of their efficiency ?

Since the second set of pumps have to do only one-eighth as much work as the first set, their efficiency would need to be only one-eighth that of the first, but since they have only five-eighths of the time to do it in, this ratio will be changed to one-fifth. Owing to the defect, however, their apparent efficiency is ten-ninths of their real efficiency, and this consideration changes the ratio to two-ninths. Again, the second set, having a combined length of stroke twice as great as that of the first, will only need a piston of sectional area half as great as the first for equal efficiency, and, $\therefore$ one-ninth as great for two-ninths the efficiency, and consequently the radius of the pistons in the second set requires to be only one-third that of the first, or 1 inch.

4, A tax bill for \$291.60 may be paid in three instalments,—\$111.60 on June 25th, \$90 on August 4th, and \$90 on October 4th. If all be paid on June 25th, a reduction is allowed of $\frac{2}{100}$ of the instalments that might have been deferred. What rate per cent. per annum is this allowing for money ?

This is equivalent to saying that the present worth of \$90 for 40 days together with the present worth of \$90 for 61 days = \$176.40 ; required the rate per cent. And the amount of \$176.40 for 101 days, diminished by the amount of \$90 for 61 days, should give \$90, that is, if $a$ be the rate per cent.

$$176\tfrac{2}{5}\left(1+\frac{101a}{36500}\right)-90\left(1+\frac{61a}{36500}\right)=90.$$

$$\therefore \frac{882}{5}\times\frac{101a}{36500}-90\times\frac{61a}{36500}=\frac{18}{5},$$

which gives $a = 10.66$.

5. A bankrupt's apparent assets are 80 per cent. of his liabilities ; but on \$20,000 of these assets he recovers only 80 cents on the dollar, and 4 per cent. of the amount the estate actually realized is consumed in the process of winding it up. He pays 60 cents on the dollar ; what were his liabilities ?

But for the 4 per cent. consumed he could have paid $62\frac{1}{2}$c. on the dollar, $\therefore$ by failing to collect \$4000 he lost $\frac{17\frac{1}{2}}{80}$, or $\frac{7}{32}$ of his apparent assets.

$$\therefore \text{app. assets} = \frac{32}{7} \text{ of } \$4000,$$

$$\therefore \text{liabilities} = \frac{5}{4}\times\frac{32}{7}\times 4000,$$

$$= \$22{,}857\tfrac{1}{7}.$$

It will be noticed that the apparent assets did not amount to \$20,000, and therefore he could not have collected 80c. on the dollar on \$20,000, as stated in the question, we have assumed, however, that the examiner merely meant that \$4000 had to go as bad debt, and have solved accordingly.

6. A gives B \$210 on May 11th, and in return takes his note at 5 months, agreeing not to exact interest. On June 11th A sells the note to C for \$205, and B makes good to A the \$5 so lost. When the note falls due C

exacts interest at 7 per cent. per annum. Find the rate per cent. per annum gained, lost, or paid by the several parties to this transaction.

A gets his money back at the end of a month, and therefore loses the use of \$210 for one month. B pays 7 per cent. for the money and \$5 more, so that altogether he pays $12\frac{5}{7}$ per cent. per annum. C invests \$205 and receives \$210 and 7 per cent. interest on \$210, this is rather more than 13 per cent. per annum for his money.

7. A municipality whose property is assessed at \$1,000,000, borrows \$40,000; find an expression for the tax (rate in the dollar) that must be levied to form a sinking fund that will repay this in 10 years, money being worth 6 per cent. per annum, the taxes being levied yearly, and money compounded half-yearly.

In ten years, at 6 per cent. payable half-yearly, \$40,000 will amount to

$$\$40000 \times (1{\cdot}03)^{20} \quad \text{(I)}$$

If $a$ be the amount added to the sinking fund each year, then the first $a$ bearing interest for 9 years will amount to $a \times (1.03)^{18}$; the second to $a \times (1.03)^{16}$, and so on, the sum of these amounts is

$$a\,\frac{(1.03)^{20} - 1}{(1.03)^{2} - 1} \quad \text{(II)}$$

and since (II) must be equal to (I),

$$\therefore a = \frac{(1.03)^{2} - 1}{(1.03)^{20} - 1} \times (1.03)^{20} \times 40000.$$

∴ the assessment would be

$$\frac{(1.03)_{20}}{(1.03)^{20} - 1} \times \overline{(1.03)_{2} - 1} \times 40 \text{ mills on the dollar.}$$

8. The sides of a triangle are 4, 5, 6; find its area.

Half sum of sides $= 7\frac{1}{2}$; subtracting sides from this, we have remainders $3\frac{1}{2}, 2\frac{1}{2}, 1\frac{1}{2}$.

$$\therefore \text{Area} = \sqrt{7\tfrac{1}{2} \times 3\tfrac{1}{2} \times 2\tfrac{1}{2} \times 1\tfrac{1}{2}}$$
$$= \tfrac{1}{4}\sqrt{15 \times 7 \times 5 \times 3}$$
$$= \tfrac{15}{4}\sqrt{7}.$$

9. Eight equal spherical iron balls, radius 1 foot, are just enclosed in a cubical box, and the box is then filled up with water; compare the weights of iron and water in the box, the specific gravity of iron being 7·79.

Give the expression for the surface of a sphere in terms of its radius.

Capacity of the box $= 64$ cubic feet.

vol. of iron $= \frac{32}{3} \times \frac{22}{7}$ cubic feet.

∴ vol. of water $= 64 - \frac{32}{3} \times \frac{22}{7}$ " (1)

which is also the weight of the water, if the weight of a cubic foot of water be taken as the unit of weight; and the weight of the iron is

$$\frac{32}{3} \times \frac{22}{7} \times 7{\cdot}79 \quad (2)$$

∴ the ratio required in that of (2) to (1) which $= 8.569 : 1$.

Surface of sphere $= 4 \times \frac{22}{7} \times (\text{rad})^2$.

10. Shew how to determine the surface of a right circular cone.

The height of the frustrum of such a cone is three feet, radius of base 2 feet and semi-vertical angle 30 degrees; find its surface. If this surface were made of paper and being cut from the cone, were spread on a flat surface find the dimensions of the curve formed by what was the bottom edge of the cone.

$$\text{surface } (8\sqrt{3} - 6) \times \frac{22}{7} \text{ sq. ft.}$$

The curve is an arc of a circle whose length

$$\text{is } \frac{88}{7} \text{ ft.}$$

# INTERMEDIATE CHEMISTRY PAPER.

*Time—One hour and a-half.*

Examiner—PROF. E. HAANEL, PH. DR.

*Paper answered by the Examiner.*

I. "$KNO_3 + H_2SO_4 = HNO_3 + HKSO_4$.

(i.) Give, first, the names of the compounds, entering into the reaction represented by above equation, and second, the names of the elements, with their combining weights, entering into the constitution of these compounds.

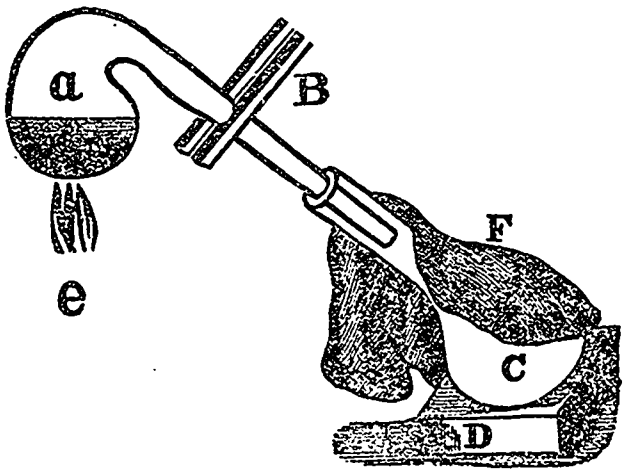
(ii.) "Represent by diagram, the necessary apparatus for conducting the experiment indicated by the equation.

(iii.) "What effect would $H_2SO_4$, $HNO_3$ and $KNO_3$, each have upon a solution of blue litmus?"

(i.) *(a)* Potassium Nitrate, Sulphuric Acid, Nitric Acid, Hydrogen Potassium Sulphate.

(*b*) Potassium (K. 39.1), Nitrogen (N. 14), Oxygen (O. 16), Hydrogen (H. 1) and Sulphur (S. 32).

(ii.)




(*a*) Retort containing Potassium Nitrate and Sulphuric Acid.

(B) Retort holder.

(C) Receiver.

(D) Block of wood serving as support for receiver.

(*e*) Source of heat.

(F) Cloth kept wet with cold water.

(iii.) $H_2SO_4$ and $HNO_3$ would change a blue solution of litmus to red; $KNO_3$ would not affect the colour of the solution of litmus.

II. "It is required to make $3\frac{1}{2}$ pounds of $HNO_3$ by experiment. How much $H_2SO_4$ is required?"

$$98 : 63 :: x : 3\tfrac{1}{2}$$

$$x = \frac{343}{63} = 5.44 \text{ lbs. of } H_2SO_4.$$

III. "Explain the principle of Davy's safety lamp."

To affect chemical union between substances capable of combining, it is requisite that they be raised to a certain temperature (termed "Temperature of Ignition") which differs for different substances. To prevent the flame of Davy's lamp from raising the temperature of the explosive gases, into which the lamp may be immersed, to the temperature of ignition, Davy surrounded the flame of his lamp with a wire gauze. The gauze admits the explosive gases to the flame, but confines their combustion within the gauze,—the conductivity of the latter (by distributing and radiating the heat resulting from combustion) preventing the gases exterior to it from reaching the temperature required to explode them.

IV. "It is required to prepare the elements

hydrogen and nitrogen for class purposes.

(i.) "Describe the apparatus and name the substances needed for the preparation of each of the elements.

(ii.) "Write out the equations representing the reactions occurring in their elimination.

(iii.) "Describe the experiments you would perform to demonstrate their distinguishing properties."

(i.) (*a*) APPARATUS FOR THE PREPARATION OF HYDROGEN.

(1.) A wide mouthed bottle capable of holding a pint or more.

(2.) A paraffined cork bored through twice and fitting gas tight into the mouth of bottle (1).

(3.) A funnel tube long enough to reach within an inch of the bottom of bottle (1), fitted into one of the borings of the cork.

(4.) A glass tube six inches long, bent at right angles, one limb of which is pushed through the other boring of the cork far enough to clear its lower surface.

(5.) Rubber tubing to connect tube (4) with gas bag or other apparatus for storing the hydrogen.

(*b*) APPARATUS FOR THE PREPARATION OF NITROGEN.

(1.) A pneumatic trough provided with shelve and filled with water to cover the shelve one inch.

(2.) A porcelain capsule containing some phosphorus.

(3.) A tubulated bell-jar placed over capsule (2) and resting on shelve of trough (1).

Substances necessary for the preparation of Hydrogen:—Granulated Zinc or Sheet Zinc in scraps, $H_2SO_4$ and $H_2O$.

Substances necessary for the preparation of Nitrogen:—Common Air and Phosphorus.

(ii.) $Zn + H_2SO_4 = ZnSO_4 + H_2$

$$P_2 + \frac{\text{Air}}{(O_5 + N_x)} = P_2O_5 + N_x \uparrow$$

(iii.) To demonstrate the LOW SPECIFIC GRAVITY of Hydrogen:

(*a*) Decant the gas upwards from one bell-jar to another.

(*b*) Fill soap bubbles with the gas.

(*c*) Suspend an inverted beaker from one arm of the beam of a balance, counterbalancing it with weights placed in the scale pan attached to the other arm of the beam. Allow hydrogen to stream up into the beaker; the scale-pan will now descend, proving the hydrogen to be lighter than air.

The combustility of hydrogen may be demonstrated:

(*a*) By igniting the hydrogen streaming through a glass tube with narrow bore.

(*b*) By igniting the gas contained in a bell-jar, holding the jar mouth downwards and applying the light at the mouth.

To prove that hydrogen is not a supporter of combustion, plunge an ignited wax taper upwards into a bell-jar filled with hydrogen and held as described in (*b*) previous answer.

The Properties of Nitrogen are wholly negative. It is neither combustible nor a supporter of combustion. This is readily demonstrated by plunging a lighted wax taper through the tubulure of a bell-jar containing the gas. The taper will be extinguished and the nitrogen fail to ignite.

V. "Assign reasons for assuming that *charcoal, graphite* and *diamond* are different modifications of the same element."

(*a*) The compounds which charcoal, graphite and diamond are capable of forming with other elements are indentical.

(*b*) For the formation of any of these compounds the same proportion by weight of charcoal, graphite or diamond is necessary.

VI. "Complete the following equations:

$Ca\,CO_3 + 2(HCl) =$

$Na + H_2O =$

$2(NaCl) + 2(H_2SO_4) + MnO_2 =$

$P_2O_5 + 3(H_2O) =$"

$CaCO_3 + 2(HCl) = CaCl_2 + H_2O + CO_2 \uparrow$

$Na = H_2O = NaHO + H \uparrow$

$2(NaCl) + 2(H_2SO_4) + MnO_2 = MnSO_4 + Na_2SO_4 + 2H_2O + Cl_2.$

$P_2O_5 + 3(H_2O) = 2(H_3PO_4)$"

VII. "Coal Gas and Phosphorus burn with a luminous, Sulphur and Hydrogen with a non-luminous flame. Account for this difference."

[Only incandescent solids and liquids furnish a continuous spectrum, therefore] Substances, the product of combustion of which is solid (rendered incandescent by the heat eliminated during combustion), burn with a luminous flame—those, the product of combustion of which is gaseous with a non-luminous flame. The product of the combustion of Phosphorus is solid $P_2 O_5$; in the case of Coal Gas, the product of the first stage of combustion is Water Gas and solid Carbon. The products of combustion of Sulphur and Hydrogen are gaseous—*i. e.* Sulphur Dioxide and Water Gas respectively.

VIII. "A certain quantity of Zinc furnished when treated with Sulphuric Acid $3\frac{3}{4}$ pounds of Zinc Sulphate. How much Zinc was employed? Zn = 65."

$$161 : 65 :: 3\tfrac{3}{4} : x$$
$$x = \frac{975}{644} = 1.513 \text{ lbs. of Zn.}$$

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## PUBLIC SCHOOL DEPARTMENT.

### THEORY OF ARITHMETIC.

*What is Magnitude?*

Anything which admits of being made greater or less is called Magnitude.

*What is Mathematics?*

Mathematics is the science of Magnitude.

*Does Mathematics treat of all Magnitudes?*

No; only of those Magnitudes which admit of being measured.

*What is meant by measuring a Magnitude?*

A Magnitude is said to be measured when we have found out how many times it contains another Magnitude of the same kind called the unit.

*What is a Unit?*

Unit or Unity is the name given to that Magnitude which is to be reckoned as *one*, when other magnitudes of the same kind are to be measured.

*What is Number?*

Number is the result of finding how often a Magnitude contains its unit.

*What is an Abstract Number?*

When a number does not express the nature of the unit which produced it, it is called *abstract.*

*What is a Concrete Number?*

A Concrete number is one which indicates the nature of the units which it represents. Properly speaking a Concrete number is not a number, but a Magnitude.

*What is a Prime Number? A Composite Number?*

A *Prime* number is one that has no divisors but itself and unity: otherwise it is *Composite.*

*What is an Even number? An Odd number?*

An *even* number is one that is exactly divisible by 2; otherwise it is an *odd* number.

*What is Arithmetic?*

Arithmetic is that branch of mathematics which treats of number, and is therefore the science of expressing numbers by symbols, and of applying rules to the various operations in which numbers are employed.

*What is Notation?*

Notation is the art of expressing any number by figures or symbols.

*What is Numeration?*

Numeration is the converse of Notation, being the art of expressing in

words any number which is already given in figures.

*What is meant by a Scale of Notation?*

By a Scale of Notation is meant an arrangement whereby all numbers can be expressed with a limited system of figures combined with each other in a suitable manner.

*What name is given to our Scale of Notation?*

It is called the Decimal or Denary scale.

*Why is it so called?*

Because *ten* units of any order are taken to form one unit of the next higher order.

*What is Addition?*

Addition is an operation by which we put together two or more numbers into one, which is called the sum.

*What is an Axiom?*

An Axiom is a self-evident truth.

*What Axiom may be used in Addition?*

It may be taken as self-evident that the sum of two numbers is the same as the sum of their several parts.

*What is Subtraction?*

Subtraction is the operation by which we remove from one number (called the *Minuend*), as many units as there are in another number (called the *Subtrahend*). The number that remains is called the *Difference.*

*What Axiom is used in Subtraction?*

It is self-evident that one number may be taken from another by taking all the *parts* of the first number from the *parts* of the second, and that their differences collected together will form the difference between the numbers.

*Which are the fundamental operations in Arithmetic?*

Addition and Subtraction.

*Why?*

Because numbers can be altered only by Addition or Subtraction.

*What is Multiplication?*

Multiplication is that process by which when two numbers are given we form a third number by repeating one of the two given numbers as many times as unity is repeated to give the other given number.

The given number which is repeated is called the *Multiplicand*, the other the *Multiplier*, and the number formed is called the *Product.* The two given numbers are also called *Factors* of the Product.

*What is Division?*

Division is that process by which we find how many times a number (called the *Divisor*), is contained in another number (called the *Dividend*), the number thus obtained being called the *Quotient*, or Division is that process by which when a number and one of its factors are given, we find the other factor.

NOTE.—(1) Dividend ÷ Divisor= Quotient.

(2) Dividend ÷ Quotient=Divisor.

(3) Divisor × Quotient=Dividend.

(4) Dividend — Divisor × Quotient = Remainder.

(5) Remainder + Divisor × Quotient = Dividend.

(6) (Dividend —Remainder) ÷ Divisor = Quotient.

(7) (Dividend—Remainder) ÷ Quotient = Divisor.

*What is a Measure of a Number?*

When one number can be divided by another without leaving a remainder, the second is said to be a measure of the first.

*What is a Common Measure?*

A number which is a measure of two or more numbers is said to be a Common Measure of these numbers.

*What is the Greatest Common Measure of two or more numbers?*

The G. C. M. of two or more numbers is the largest number that will divide each of them without a remainder.

*What is a Multiple of a number?*

A Multiple of a number is the product of that number by any other number.

NOTE.—*Sub-multiple, Measure, Factor, Divisor*, have all the same signification.

*What is a Common Multiple of two or more numbers?*

A Common Multiple of two or more numbers is a number that will contain each of them as an exact divisor.

*What is the Lowest Common Multiple of two or more numbers?*

The L. C. M. of two or more is the lowest number which is exactly divisible by each of them.

*(To be continued.)*

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## GRADED COURSE OF INSTRUCTION.

### EIGHTH GRADE.

*(Time allowed—about 5 months.)*

#### READING.

The first 82 pages of the Fourth Reader. See previous remarks on reading.

#### SPELLING AND DICTATION.

On paper any 15 consecutive lines in the limit.

#### WRITING.

Copy book No. 5, large size.

#### ARITHMETIC.

1. Review previous limits.
2. Vulgar fractions.
3. Problems involving Square Measure—carpentering, painting, plastering, papering, &c.
4. Mental Arithmetic (daily).

#### GEOGRAPHY.

1. Review previous limits.
2. To know the definitions and uses of meridian, equator, parallels of latitude, tropics, zones, arctic and antartic circles.
3. Draw a map of Asia, showing the relative positions of the countries and their capitals, and locate correctly the following:

(1). *Mountains*:—Altai, Yoblonoi, Thian Shan, Pe-ling, Nan-ling, Yun-ling, E. Gauts, W. Gauts, Hindoo Koosh, Suleiman, Elburz, Ararat, Taurus, Anti-Taurus, Sinai.

(2). *Rivers*:—Obi Yenisei, Lena, Amoor, Hoang Ho, Yang-tse-Kiang, Cambodia, Meinam, Irrawady, Brahmaputra, Ganges, Indus, Oxus, Tigris, Euphrates.

(3). *Lakes*:—Baikal, Balkash and the inland seas, Aral, Caspian and Dead Sea.

(4). *Seas*:—Behring, Okotsk, Japan, Yellow, China, Arabian and Red.

(5.) *Gulfs and Bays*:—Anadir, Tartary, Pe-che-le, Tonquin, Siam, Martaban, Manaar, Cambay, Cutch, Oman, Persian, Aden.

(6). *Channels, Straits and Sounds*: Behring, LaPerouse, Corea, Formosa, Macassar, Sunda, Malacca, Palks, Bab-el-Mandeb, Ormuz.

(7). *Islands*: — Aleutian, Kurile, Saghalein, Japan, Loo-Choo, Formosa, Hong-Kong, Hainan, Philippine, Borneo, Labuan, Celebes, Moluccas, New Guinea, Java, Sumatra, Andaman, Nicobar, Ceylon, Maldive, Laccadive.

(8). *Capes*:—East, N. East, Lopatka, Cambodia, Romania, Negrais, Comorin, Ras-al-Had.

(9). *Cities*:—The capitals of the countries and the following important cities:— Smyrna, Scutari, Sinope, Trebizond, Erzeroum, Kars, Damascus, Jerusalem, Acre; Mecca; Ispahan; Candahar, Herat; Kelat; Delhi, Benares, Lucknow; Calicut; Hyderabad, Kurrachee; Colombo, Trincomalee; Ava, Bangkok, Hue, Rangoon; Canton, Amoy, Hong Kong; Cashgar; Samarcand; Tobolsk, Onisk.

4. Draw a map of Africa, showing the relative positions of the following :

(1). Countries and the Capitals.

(2). Barbary States.

(3). *Mountains:*—Atlas, Kong, Cameroons, Kelmandjaro, Snow, Moon.

(4). *Rivers :*—Nile, Niger, Zambeza, Limpopo, Orange, Congo, Senegal.

(5). *Lakes :*—Tchad, Albert and Victoria, Nyanza, Tanganyeka.

(6). *Gulfs and Bays :*—Cabes and Sidra, Sofala, Delagoa, Algoa, Walfrisch, Bights of Benin and Biafra.

(7). *Channels and Straits :*—Gibraltar, Bab el-Mandeb, Mozambique.

(8). *Islands :* — Madagascar, Canary, Madeira, Socotra, St. Helena.

(9). *Capes :*—Bon, Blanco ; Verde, Palmas, Lopez, Frio ; Good Hope, Agulhas, Corrientes, Delgado, Guardafui, Amber and St. Mary.

(10). *Cities :*—The capitals and the following :—Fez, Carthage, Alexandria, Thebes, Timbuctoo ; Natal, Cape Town.

GRAMMAR.

(1). Review former limits.

(2). Distinction of any part of speech in a simple sentence.

(3). Comparison of adverbs and adjectives.

(4). Declension of pronouns.

(5). Relation and parsing of nouns, adjectives, pronouns, and adverbs in simple sentences.

(7). Separation of simple sentences into simple and completed subject and complete predicate.

COMPOSITION.

(1). To write simple sentences of a specific kind on any familiar subject.

(2). To write compound sentences on any familiar subject.

(3). To combine statements into simple sentences, or separate simple sentences into statements.

(4). To date, address, compose, subscribe and superscribe a letter on any common topic.

(5). To give a short narration of any familiar circumstance.

HISTORY.

*1. Canadian.*

(1). To Explain meaning of treaty and to know how the treaties of 1713, 1748 and 1763 affected Canada.

(2). To know how Canada was governed up to 1759; to 1792 and since that year.

(3). To know what is meant by representative government, when it was introduced and when the capitals were.

(4). The provinces of the Dominion, where their parliaments meet; where the parliament of all meets.

(5). How Newfoundland was governed.

2. *English History.*

(1). The condition of the people B. C.

(2). The Roman Conquest—Why? When? Condition of the people afterwards.

(3). The departure of the Romans —When? Why? Result?

(4). Coming of the Saxons—When? Why? Heptarchy, (Not the names of the kingdoms); its end? Why? First called England?

(5). Coming of the Danes—Why? When? Alfred the great. Dangelt; Why paid? Who tried to avoid paying? Why? When? Result?

(6). Danish rule began—Name of kings? Ended? Result? Condition of country and people?

(7). Restored Saxon Line; Kings? William the Norman; His claim? Hastings?

(8). Names of subsequent sovereigns by Houses, together with the date of the beginning of each House and the date of its end, thus :—

NORMAN LINE.

| Began 1066, | Ended 1154. |
|---|---|
| 1. William I. | 3. Henry I. |
| 2. William II. | 4. Stephen. |

DRAWING.

(1). Review previous limits.
(2). Drawings of simple objects, domestic utensils, &c.

ELEMENTARY SCIENCE.

Oral instruction; simple outlines of hygiene.

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## NINTH GRADE.

(*Time allowed—about 5 Months.*)

READING.

Fourth Reader, first 138 pages.

SPELLING AND DICTATION.

(1). To know the spelling and meanings of all words in the reading limit, especially those beginning on pages, 1, 30, 34, 46, 88, 93, 139, 144, 157, 161. (2). Spelling rules 3, 4, 5, 6, 7, 8—pages 24 to 26 of spelling book. (3). Pronounce correctly the words on pages 39-64 of spelling book. Punctuation, Dictation—Test, any 15 lines in reading limit.

ARITHMETIC.

(1). Review previous limits.
(2). Reduction of fractions.
(3). Simplifying fractional quantities.
(4). Decimal fractions to repeating decimals.
(5). Problems involving fractions and cubic measure.
(6). Mental arithmetic (daily).

GEOGRAPHY.

1. Review all previous limits.
2. To be able to mark correctly on a map the following:

(1). *Mountains:* — Scandinavian, (Dovrefield, Langfield and Kiolen), Grampians, Penine, Cambrian, Alps, Jura, Cevennes, Pyrenees, Castile, Morena, Sierra Nevada, Appenines Balkan, Carpathians, Black Forest, Harz, Erz, Sudetic, Caucasus, Ural.

(2). *Rivers:*—Petchorn, Duina, Vistula; Oder, Elbe, Rhine; Seine, Loire, Garonne, Rhone; Douro, Tagus, Guadiana, Ebro; Thames, Clyde, Shannon; Po, Arno, Tiber; Danube; Don and Volga.

(3). *Lakes:*—Wener, Wetter; Ladoga, Onega; Geneva, Constance; Maggoire, Como; Derwentwater, Windermere, Lomond, Katrine, Neagh, Killarney.

(4). *Seas:*—White, Baltic, Mediterranean, Adriatic, Marmion, Black, Azov.

(5). *Gulfs and Bays:*—Bothnia, Finland, Riga; Cattegat, Skager Rack; Bay of Biscay; Lyons, Genoa, Taranto.

(6). *Channels and Straits:*—Great Belt, Little Belt Sound; Dover, English Channel, St. George's Channel, North Channel, Gibraltar, Bonifacio, Messina; Dardinelles, Bosphorus, Kertch.

(7). *Islands:*—Nova Zembla, Spitzbergen; Zealand, Funan, Gotland; Iceland; British Islands (Great Britain, Ireland, Orkney, Shetland), Hibrides, Azores; Balearic (Majorca, Minorca, Iovica), Sardinia, Corsica, Sicily, Malta, Ionian, Candia, Negropont, Cyclades.

(8). *Peninsulas:*—Scandinavian, Jutland; Iberian. (Spain and Portugal), Italy, Morea, Crimea.

(9). *Capes:*—North, Naze, Skay; Duncansby Head, Clear, Land's End; LaHogue; Ortegal, Finisterre, St. Vincent; Tarifa, Passaro, Spartivento, Matapan.

(10). *Cities:*—The capitals and the following cities:—Newcastle, Carlisle, Durham, York, Leeds, Liverpool, Birmingham, Cambridge, Oxford, Dover, Caernarvon, Cardiff, Swansea; Inverness Aberdeen, Perth, Glasgow; Londonderry, Belfast, Cork; Upsala, Gothenburg; Kronstadt, Rega, Archangel, Moscow, Odessa, Sebastopol, Astrakan, Warsaw; Rotterdam, The Hague, Utrecht; Antwerp, Leige; Versailles, Lyons, Marseilles, Bordeaux, Rouen, Orleans, Bayonne;

Barcelona, Seville, Cadiz, Granada; Oporto; Elsinore; Leipsic, Weimar, Hamburg, Bremen, Munich, Augsburg, Heidelberg, Metz, Breslau, Cologne, Coblintz, Frankfort; Pesth and Buda, Cracow; Geneva, Lucerne; Turin, Genoa, Milan, Florence, Naples, Venice; Navarino; Adrianople.

(2). Map of Nova Scotia, including Cape Breton, marking the following:

*Capes.*—St. Lawrence, Canso, Sable, Chignecto, St. George.

*Bays.*—Bras-d'Or, Chedabucto, Halifax Harbor, Funday, Chignecto, Cobequid.

*Towns and Cities.*—Halifax, Windsor, Sydney, Pictou.

GRAMMAR.

(1). Review former limits.

(2). Principal grammatical forms and definitions.

(3). Conjugation and inflection of verbs.

(4). Distinction of phrases.

(5). Analysis of any simple sentences with parsing and relation of its words.

COMPOSITION.

(1). To write simple and compound sentences on any familiar subject.

(2). To combine simple sentences into a compound sentence, or separate a compound sentence into simple sentences.

(3). To change the construction of sentences by voice, progressive and emphatic forms.

(4.) To write in the form of a letter narrating any remarkable circumstances, or describing any familiar incident.

HISTORY.

1. *Canadian.*

(1). Review previous limits.

(2). British possessions in North America in 1863.

(3). When and why did they separate from Great Britain? How did this affect Canada? Explain U. E. L.

(4). Constitutional Act, date, why so called; what kind of Government did it introduce?

(5). War of 1812.—Cause. Battles.

(6). Act of Union 1840.—Explain briefly. B. N. A. Act 1867.—Explain briefly.

(7). Names of Governor-Generals since 1876, and present Lieutenant Governor of Ontario.

ENGLISH.

2. (1). Review previous limits.

(2). State the claims of each sovereign to the throne from 1066 to the present time, and give his relationship of his predecessor.

(3). Character of each sovereign since 1066, leading features of his time and the two leading events of his reign.

WRITING.

Copy Book No.——.

DRAWING.

As in preceding grades, with sphere, spheroids, hemisphere, and shading begun.

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## TENTH GRADE,

*(Time allowed—about 5 months.)*

The limit for this grade is that for admission to High Schools and Collegiate Institutes. It is prescribed by the Minister of Education and is as follows:—

SPELLING.

Fourth Reading Book to p. 246, and Spelling Book.

WRITING.

Neatly and Legibly.

ARITHMETIC.

Principles Arabic and Roman Notation; Vulgar Fractions; Decimal Fractions; Simple Proportion with reasons of rules; Mental Arithmetic.

GRAMMAR.

Principles Grammatical Forms and Definitions; Analysis of Simple Sentences; Parsing Simple Sentences.

COMPOSITION.

Simple and Complex Sentences, orally or in writing; Grammatical Changes of Construction; Short Narrative or Description; Familiar Letters.

GEOGRAPHY.

Maps of America, Europe, Asia and Africa; Maps of Canada and Ontario.

LINEAR DRAWING.

Outline of Maps; common objects on paper.

HISTORY.

Candidates will be examined in the leading facts of English History. The questions set will not demand a minute knowledge of details, but will be strictly limited to the outlines of the subject.

READING.

Candidates will be examined, as heretofore, in reading from the Fourth Reader, pp. 1-246; but they will, in addition, be expected to show that they understand the meaning of these reading lessons.

They will likewise be examined, more minutely on the selections enumerated in the following list, and they will be required to reproduce the substance of one or more of them in their own language:—

(1). The Norwegian Colonies in Greenland.—*Scoresby.*

(2). The Founding of the North American Colonies.—*Pedley.*

(3). The Voyage of the "Golden Hind."—*British Enterprise.*

(4). The Discovery of America.—*Robertson.*

(5). The Death of Montcalm.—*Hawkins.*

(6). Jacques Cartier at Hochelaga.—*Hawkins.*

(7). Cortez in Mexico.—*Cassells' Paper.*

(8). The Buccaneers.—*The Sea.*

(9). The Earthquake of Caraccas.—*Humboldt.*

(10). The Conquest of Peru.—*Annals of Romantic Adventure*

(11). The Conquest of Wales.—*White's Landmarks.*

(12). Hermann, the Deliverer of Germany.—*Jerrer.*

(13). The Burning of Moscow.—*Segur's Narrative.*

(14). The Battle of Thermopylæ.—*Raleigh.*

(15). The Destruction of Pompeii.—*Magazine of Art.*

(16). The Taking of Gibraltar.—*Overland Route.*

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## NATURAL SCIENCES IN OUR SCHOOLS.

IT is becoming more and more evident that the Natural Sciences do not receive that attention in our Public and High Schools that their great value demands; while nearly one-half of the time in school is taken up with Mathematics alone, but little or no attention is given to the study of Natural Sciences. The cause for this state of affairs is not far to seek. In the course of study prescribed by the Minister of Education for our Schools but little prominence is given to Science; the course laid down in Mathematics, in English, in Literature and in the Languages (ancient and modern) is very extensive, while Chemistry and Heat are the only branches of Physical Sciences recognized by the Education Department in its published curriculum. Now that the standing of teachers depends to a great extent upon the number of pupils they can put success-

fully through the ordeal of some written examination on the work of the School course, it is not to be expected that teachers will give any attention to a kind of instruction, however useful it may be, that will not count on the day of examination.

In the United States, Natural Sciences are taught to a greater extent than with us. Physics, Chemistry, Mineralogy, Geology, Physiology, Zoology and Botany find a place in nearly all American school curricula, and text books upon all these branches of study are graded to the varying capacities of the pupils. In Ontario, our school work is characterized by the almost total absence of Science teaching. Not only is the instruction given very limited in amount, but the kind is not what it should be. Ontario Schools are immeasurably behind those of the United States, not only in the extent, but also in the nature of the scientific teaching.

At the Saratoga meeting of the "American Association for the advancement of Science," a Committee was appointed to enquire into and report upon the Science teaching of the Public Schools of America, and the results of this investigation were embodied in a paper which was read last year at the meeting held in Boston. "The time has fully come," says the report, "when the system of public instruction must be measured by the standards of Science and approved or condemned by the degree of its conformity to what these standards require. Science has become in modern times the great agency of human amelioration, the triumphs of which are seen on every hand; it has advanced by the promotion of original investigation, which depends upon men prepared for the work. To the Schools is given the task of moulding the youthful mind of the country. Do the schools of the country, by their method of scientific study, favour or hinder this object? Do they foster the early mental tendencies that lead to original thought, or do they thwart and repress them? So far as Ontario Schools are concerned, the results of the intermediate and first-class examinations obtained during the past few years compel us to say that our system of school examinations tends to repress originality of thought. "To awaken the spirit of enquiry, to cultivate the habit of investigation, and to rouse independent thought, are the grand ends to be secured in a true education." Science is an outgrowth of common knowledge, and the Scientific method is but the development of the ordinary processes of thought, that are employed by everybody. "The common knowledge of the people is imperfect, because their observations are vague and loose, their reasonings hasty and careless, their minds warped by prejudice and deadened by credulity."

"The scientific method is simply a *systematic* exercise in truth-seeking, and is the only mode of using the human mind when it is desired to attain the most accurate and perfect form of knowledge. It is applicable to all subjects whatever, that involve constancy of relations, cause and effects, and conforms to the operation of law. In our Public Schools little use is made of this method in the work of mental cultivation; the pupil learns the facts and principles of science from books and from teachers, much as he learns Geography and history; thus treated the Sciences have but little value in education. The Sciences should be made the means of cultivating the observing powers, of stimulating enquiry, of exercising the judgment in weighing evidence and of forming original and independent habits of thought. As remarked by Agassiz, "The pupil studies nature in the school-room, and when he goes out of doors he cannot find her." Judicious oral assistance, as given in the physical,

chemical and natural history laboratory, by a competent master to a pupil at work, is invaluable for stimulus and guidance; but "when there is all talk and no work, and text-books are filtered through the very imperfect medium of the ordinary teacher's mind, and the pupil has nothing to do but to be instructed, very sound principle of education is outraged, and Science is only made ridiculous."

These views embody the thoughts of the leading educationists of America, and it behooves Canadians who are giving direction to educational effort to weigh well the conclusions arrived at by this committee after a careful and exhaustive enquiry. To bring this scientific method into our High Schools, and make its influence felt in the Public Schools, is a pressing necessity; for upon the wide-spread diffusion of science depends in a great degree the development of the natural resources of our country. To bring about the necessary reform, we must begin with the High Schools, for it is here that the Public School teacher is now to receive his education. Under present conditions a remedy is impossible; the course of study for our schools must be adhered to, and this course does not recognize practical work in Science. Now, what is the remedy for all this? Already a Science course is prescribed for 2nd class teachers' examinations, but this does nor go far enough: let this option be also extended to 1st class teachers who have the highest grade of certificate in view; let it embrace not only an accurate knowledge of inorganic Chemistry, but also a practical course in qualitative analysis. The candidate for 1st class certificate in Science should be able to determine by means of the blow pipe the commonly occurring economic minerals of Canada, and he should have a practical acquaintance with the general principles of crystallography. He should have a general knowledge of vegetable physiology, and by the use of a "manual" be able to determine plant species. Huxley and Martin's work on elementary Biology would open up to him a vast field of observation, besides give him a knowledge of the use of the microscope. Physical Geography and all that the subject embraces should be extended into the domain of Geology to which it naturally leads. It is not enough that the student should know the facts to be taught in this course; he should know them practically, and the examination should be so arranged as to afford an opportunity to the candidate for a 1st A or B certificate in the Science option, of showing that he understands and appreciates scientific methods, whether he knows all the facts or not.

No one can measure the force which a number of students trained in the methods of practical chemistry and determinative mineralogy, scattered throughout our new and undeveloped country, would exert in the domain of original science work. The Universities cannot give this culture to the Public School teacher, inasmuch as the science course of the University is hedged in with Classics, Modern Languages, and Metaphysics. A candidate for 1st Class Public School Teacher's certificate cannot afford to devote years of study in the non-scientific subjects, in order to enter upon a course in Science training. What the Minister of Education should do is to place it within the range of possibility for a young man who does not possess a classical education, to enter at once upon a course of Science training in some of our High Schools. The easiest way of bringing a practical knowledge of Science among the people is to make a scientific course of training for the students attending our High Schools and Collegiate Institutes permissible.

The question naturally comes up.

Are our schools equipped for the work? Can they, without neglecting the work already prescribed, undertake the training of students in a Science course, such as we have indicated above? Can they, without undue strain upon the energies of the masters, afford instruction in a Science course equivalent to that now required of them in the departments of Mathematics, of English and Literature, of Classics, and of Modern Languages? They are certainly not all equipped, but some of them are well able for the work. It would indeed be a strange commentary on our Universities, if the specialists they turn out in this department were not as well qualified for the work as the specialists in the other Departments.

A school employing the services of two or three masters ought not to undertake the work of training students beyond the Intermediate limit and the standard required for pass Matriculation in the University. A school having four department masters can do 1st C work and train candidates in the limit prescribed for Junior Matriculation with honors. These schools should not attempt first A work in any department, nor should they undertake the 1st year work of the University. There are several Collegiate Institutes employing a teaching force of from 8 to 16 masters that are well able to teach the subjects of the four departments, Mathematics, Classics, Modern Languages and Science up to the same standard in each, and it is to these schools that we must look for the training requisite to obtain a first class A or B certificate in the non-professional subjects.

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The *Canada School Journal* says — "We are in receipt of a letter from Mr. Parker, complaining of an unfair criticism of his "Cicero pro Arabia," by the editor of a Toronto publication. The editor in question is permanently bilious and afflicted with the idea that he can write English. Of course he 'knows little of English and less of Latin." We are very glad indeed to see such evidence of improvement in the English of the *Journal*. The editor must not imagine, however, because he is getting along nicely, and making genuine improvement, he therefore knows all about writing good English. It was not so very long, indeed, since he was careful to avoid all sentences of an involved or complex nature, and was wont to content himself with editorial productions beginning thus: "Young America *is* charged with a lack of respect for *their* seniors. There is usually a reason for making the charge. This is not to be wondered at. The boys do not deserve the blame. They naturally prefer to be respectful. They take a delight in showing courtesy to those in authority over them." (The italics are ours.) It is extremely fortunate that ignorance of good English is not absolutely inconsistent with most thorough classical scholarship, otherwise the brilliant genius of the man who could write "Cicero pro Arabia" might have been lost to the world. Modesty in a man of real genius is perhaps not so rare a thing as to deserve comment, but that modesty which does its possessor an injustice and puts the government to the expense and trouble of sending a minister or two to a foreign country to look up a Professor of Classics when an abler man could have been had at home, is very rare indeed, and when found in the person of the editor of a Toronto Trade Journal almost ceases to be a virtue.

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The record of Hamilton Collegiate Institute at Toronto University Examinations for the year 1881 is as follows - 15 entered for the Examinations and all passed, winning the following places of honor:—

1st in Mathematics, 1st year, 1st in General Proficiency, 1st year; 1st in Classics, Junior Matriculation, 1st in Mathematics, Junior Matriculation; 1st in Mathematics, Senior Matriculation.

*(Ex-Students are not included in this record.)*