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THE SCHOOL MAGAZINE.

JUNE, 1880.

"THE NEW DEPARTURE."

THE NEW DEPARTURE IN THE COMMON SCHOOLS OF QUINCY.—BY CHARLES F. ADAMS.

This pamphlet comprises the opinions on which the "new departure" of education in the public schools of Boston has been carried out. The reader is rather surprised, or would be, if he did not know beforehand that Mr. Adams was a man of sense, with very practical opinions on most subjects, to learn that it is a very sensible pamphlet. So much has been said, and upon the whole so absurdly said, about the "new departure," as to lead people to suppose that Boston has just been revolutionizing lower education as Cambridge is supposed to have revolutionized higher education. There was an anonymous account of the new departure in the January number of the *Atlantic Monthly*, which announced that the old system which had endured so long "seemed to be crumbling," and the disintegration of it was finally to be accomplished by some new text-books already authorized in the schools of Boston. These text-books, published by Lee & Shepard, consist of four little volumes, two of them in paper covers, and are entitled respectively "Poetry for Children," edited by Mr. Eliot superintendent of the Boston schools; "Six Stories from the Arabian Nights," also edited by Mr. Eliot, and two series, each of "Six Popular Tales," edited by Henry Cabot Lodge. Neither is there anything in these to account for the paeans which from other places than the *Atlantic* have been sounded for the "new departure." The old system, as the *Atlantic* writer explains, is the system "of routine and of cram." Its chief fault besides that it "enfeebles the mind by overloading it with undigested matter" is that "it crushes out originality by discouraging all independent thought." The great need of this country is notoriously the need of more Independent Thought by Independent Thinkers of from five to twelve years of age. If the object of the new education is to develop originality in minds of this sort, that education would be a revolution indeed. The "old system" would collapse, and we should have the pleasure of recognizing, as soon as the new "system" got well under way, a

generation of the most outrageous prigs on the face of the earth. Fancy the eagerness on the part of everybody who met him to shed the blood of a boy of twelve who had been for seven or eight years under a "system" designed to stimulate his originality and encourage his independent thought. In fact, long before the new departure there were boys of this intolerable variety. Consider a society of which this young miscreant was typical, and the whole community to be inoculated with his complaint at an early age and at the public cost.

Well, as we say, one is refreshed to find that Mr. Adams has no such ideal in view. Only one of these papers is about the new departure. One of the others is about "the public library and the public schools," and the third about "fiction in public libraries and educational catalogues. Mr. Adams has nothing to say which sounds anything like so large as would be imagined, nor any principle which could be printed in capitals. In fact, his main principle is that you may lead a horse to the water, but you cannot make him drink, and he applies this to the conduct of public libraries as well as of public schools. In regard to libraries he makes a very obvious distinction, which, nevertheless, we do not remember to have seen drawn before. It is that literary amusement, however harmless or even wholesome it may be, should no more be supplied at the public expense than any other form of harmless and wholesome amusement; and that to provide young readers with all the current fiction, for example, is "something which seems very like the *pancm-et-circenses* principle." What he proposes is that libraries and public schools, considered as instruments of education, should both be managed with more reference than they are now to the needs and to the appetites of the people who are to be taught by them. The application of this and of other equally practical notions to the public schools of Quincy, under the administration of a committee composed of Mr. Adams and other citizens like minded with him, and by means of an enthusiastic superintendent, has resulted in what may be called a new system, even if it cannot without an inflation of the fact be called a New System. Too many things are attempted, Mr. Adams insists, and children who can make a brilliant figure at an examination cannot read or write decently. Reading and writing are first taught, and one peculiarity of the Quincy schools, which has now apparently been extended to the Boston schools, is that the children are taught to read and write before they are taught to spell, and they are not taught grammar at all. These are not new ideas and Mr. Adams claims no novelty for them. They are commonly applied to teaching modern languages. Applying them to the arts of reading and writing English seems to have resulted in great progress in those arts at Quincy. This is Mr. Adams's statement:

"When, after three years, a class brought up under the new system was put to the test, the examiner expressed a 'doubt if one scholar in ten knew what a noun, a pronoun or an adjective was or could have parsed a sentence or explained the difference between its subject and its predicate. They could, however, put their ideas into sentences on paper with correctness and facility; and, though they could not define what they were, they showed that they could use nouns, pronouns and adjectives, in writing, just as well as they could in speech.' Out of 500 grammar school children, taken promiscously from all the schools, no less than 400 showed results which were either excellent or satisfactory. That the scholars could read at sight, without bungling and stumbling over every unusual word the moment they left the familiar page of their Readers—that they could write a simple letter without being painfully conscious of an unaccustomed labor—these, though very considerable, were by no means the only or even the most noticeable results of a new departure. In the upper grammar as well as the lowest primary there was an entire change of spirit, and going to school was no longer what it had been. This was recognized

by the parents quite as much as by the teachers. Not only was there a marked improvement in attendance, but the attendance was cheerful."

The method of teaching seems to be that, before books are used at all, words, the meaning of which is known to the children, are written down on a blackboard and the children taught first to recognize and then to imitate them. Not until after the words are learned singly and composed into sentences are they decomposed into their letters and these letters taught. In other words, one symbol for a known thing is used instead of two, and children are brought one step nearer to a fact which it is possible for them to understand and to take an interest in. No doubt this is a great improvement. The three R's and geography are the only studies pursued in the primary schools. In geography, something like Pestalozzi's method is adopted, and quite young children are taught to model continents and to indicate contours in clay. In arithmetic, Mr. Adams admits, no considerable improvements have been made on the existing methods. This is what we should expect, since figures are arbitrary symbols of abstract properties of things, and it is quite impossible for a young child to take an interest in the relations of figures unless he can be made to connect them at once, as in Quincy he is taught to connect the alphabetic symbols with things themselves. Mr. Adams's paper does not go into detail, except about the primary schools. He says that a system essentially the same as the primary system is carried through all the grades, but it would be interesting to know how this is done. The Quincy Committee cut down the number of studies, upon the ground that "smatter" and "veneering" were the products of the ordinary methods, and aimed at nothing beyond "a thorough grounding in the elements of knowledge," a phrase which may mean either much or very little.

The text-books of the Boston schools do not constitute so much of a revolution as the Bostonian writers had led us to suppose. Superintendent Eliot's collection of poetry for class reading indicates that the people who got up text-books under the crumbling system knew what they were about. Nearly all the poems of which it consists are to be found in American school readers of a generation ago. Those which are now first collected for the use of schools are some of them good straightforward ballads, but more of them selections, from Wordsworth and Tennyson and Coleridge and Charles Lamb and Lowell and Emerson, of poems of a studied simplicity of language, but full of a brooding self-consciousness which is at once incomprehensible and revolting to a healthy child. It may be that we are wrong to limit in this way the intellectual capabilities of the Bostonian child, but for children of less favored climes there is a good deal of deadwood in the book. The other books are excellent in their way, both the collection from the "Arabian Nights" and Mr. Lodge's selection, which comprises "Cinderella" and "Jack and the Beanstalk" and "Blue Beard," and several other of the stories in which well regulated children have taken delight from time out of mind. There does not seem to be any revolution in them. Children can scarcely read them at an earlier age than that at which children have always read them. The difference is, that they are to be read, not by children sprawling prone on the floor with their chins in their hands and their abstracted legs waving in the air, but by children sitting in rows in class-rooms. The trouble about them for teaching is the notorious fact that what is a task in childhood very seldom becomes a pleasure. Mr. Adams relates that his father put him through

"Pope's Messiah" as an improving exercise at home, and that he has hated the poem ever since. This is a natural result, and would be even if "Pope's Messiah" were the proper nourishment for infant mind. These stories are better for that purpose, as school children can find out for themselves without the assistance of a superintendent of education. A boy who is "put through" Cinderella by way of learning to read, will most likely learn to read sooner than if he had been given dryer husks; but Cinderella will never be the same story to him as to another boy who got it up on his own account and out of school hours. This is worth thinking of, while we are administering the jalap of knowledge in the sugar of fiction. Young students of the piano are apt to demand "tunes" at the first stage of their education; but judicious teachers keep them on exercises, and allow them tunes for recreation. There is sense and practicality in the Quincy method as it is expounded by Mr. Adams, who is not responsible if it has been made ridiculous by the exposition of other people. It is evidently possible, however, that it should be carried too far, and there are people who will view with apprehension and alarm the extent to which it seems to have gone in Boston. The publishers of the text-books declare that they constitute "a New Era in public-school instruction," and that henceforth "The Teacher" is "a Friend and not a Terror," which will be good news to bad boys. Bad boys object violently to the system which is now crumbling, resent warmly the crushing of their originality, and believe they ought to be encouraged to Independent Thought.

COUNTRY SCHOOLS.

(Contributed.)

In the columns of our Educational journals are numerous articles bearing upon methods of teaching—almost everything—papers by experienced Heads of High Schools, Academic Institutions, occasional articles on matters connected with intellectual training, from some of our justly noted Professors—all sound and well worthy of careful perusal; but in all the pictures of the various avenues leading to the fair temple of knowledge, mention is seldom made of the Country School.

It is quite the fashion among those whose knowledge of children is confined to those found in the higher classes in town schools, to speak of childhood in laudatory terms, and when mention is made of the children who fill up our country schools, it is usually in a rather poetical strain, something after the following style:—

"And what can be more pleasantly suggestive of the onward march of civilization than the picturesque school-houses scattered through our rural sections, and the troops of rosy-cheeked children, wending their way, books in hand, &c., &c."

That is all very well for rhetoric, but we propose to discuss some matters connected with Country Schools and School Sections, premising that "we have been there," and that every scene is "from life."

The position of teacher in a country school is no sinecure,—the opinion of

the worthy residents of the section to the contrary, notwithstanding. What teacher has not heard—"Oh, you have the easy times, only to sit still and hear lessons, use the rod a little now and then, nothing to do on Saturdays, and pay for your vacations." We admit that in certain cases the picture is a true one. Many school sections employ as teacher some young man or woman who has acquired his or her education, such as it is, in that or a neighboring school, and and being "smart" has got a certificate, on the strength of which the work of teaching is commenced, with no idea on the part of the teacher as to the best way, or indeed any way of securing discipline and imparting instruction. We will not say that in these cases our rural friends are astray in their remarks, but the want of discrimination in their application is a mill-stone around the neck of the teacher who knows how to work, and does work conscientiously. The class of teachers first mentioned do, and ought to work for a much smaller salary than the trained and experienced teacher, so that unless the latter has the unheard of good fortune to find a rural section which knows and is willing to pay for the difference, he gives up the idea of a country school in disgust, and seeks employment in town schools. It is not altogether the financial side of the question that decides the class of teachers generally found in country schools,—I say generally—for here and there is an exception.

Lack of appreciation will in time discourage the most faithful and determined of workers, and for one section which appreciates and co-operates with its teacher nine do neither. Practically, some children—too many—attend school with the firm impression that they are to meet there, not a friend and helper, but a natural enemy. The idea is not "indigenous," but is implanted by the child's elders, fostered by his being encouraged to repeat at home all that comes within his observation at school, and listening to criticisms on his version of his teacher's proceedings; under these conditions very little time suffices to make the child an adept as a reporter, possessing in a high degree the indispensable reportorial quality of imagination, and good for nothing else. Any case where severe discipline has been found necessary for the mental or moral improvement of a pupil, is made the subject of discussion at numerous neighborhood tea-drinkings; any grievance—real or supposed—is made much of; charges of tyranny, partiality, &c., are made against the teacher, his efforts to govern and instruct the pupils under his charge misconstrued, and his authority weakened.

In every Section will be found a few—may their number increase—who feel an interest in the children, their work, and their teacher. They are the oases in the desert;—then there are the people who know nothing about the school; their children never say anything against the teacher, nor anything *for* him, might be added; *they* are the long, dreary stretches of sand in the desert, wearying to soul and body, and sometimes dangerous in time of storms. A third class are the active fault-finders, the brambles, briars, thorns; as a rule they never visit the school, but are fond of saying that "Somehow or other, their children don't seem to learn anything; the teacher don't get them ahead any," but they never look inside the school-room to see why such a state of things exists. Probably the programme in case of the pupils who "don't get ahead" is about as follows:—

"Tom" or "Susan," as the case may be, "hates to go to school so bad that I didn't make him (or her) go

to-day; I don't see how it is that I have to fairly drive my children to school; there must be something wrong with the teacher," comments Tom's parent, in Tom's hearing, and any compunction which Master Tom may have felt at shirking the earnest appeal of last night from the teacher, to come with the neglected work of yesterday done, vanishes instanter, as he too concludes that "there is something wrong with the teacher."

When at last he does go he is late, wastes time finding out "where his lessons are," and then does his best to get rid of working at them. About the middle of the afternoon he comes up with "I've got to go home," and if allowed to do so gets out of his afternoon's work in that way. By-and-bye the teacher determines that if Tom *will* come late and *must* "go home" early, he shall do his work, the lessons must be learned, exercises corrected, &c., upon which our young friend "stays out" indefinitely, or possibly goes to a neighboring school, whose teacher has the faculty of "getting the children ahead."

A fruitful source of disturbance in country schools is the difference in opinion between parents and teacher in regard to the prescribed work, which the teacher is in duty bound to see done by each class so far as practicable. It is a fact that a strong prejudice exists among many parents against the study of geography, history and grammar, and it has been necessary more than once in the writer's experience to "fight it out on that line."

In one school of over fifty pupils a large proportion gravely stated that they would only study reading, writing and arithmetic. With one exception, however, they did the work assigned to the classes. The exception was a boy in the third-book who exhibited a decided disinclination to do anything, which disinclination was carefully encouraged by his father—a trustee—and it was only after a pitched battle that the boy was made to put in an appearance when his classes were called; learn his lessons he never would and never did, being an eminent example that "ignorance *is* bliss" or at any rate that ignorance is perfect content. Of course the old law about employment for idle hands held good; the boy was continually in disgrace and was ultimately removed by his irate father. Previous to the boy's permanent removal, he one day left school on account of being reprimanded for some misdemeanor—and before any action was taken in the matter by the teacher, the following model epistle was received from the judicious paternal relative:—

Feb. —— 187—.

"Whereas you have expeld my son contrary to law i hereby notify you to atend a trustee meeting to anser to that and other charges."

(Signed) T———.

Notwithstanding that this lucid document gave neither time nor place of meeting, yet the Police Magistrate of the place was interviewed to see if the "Teacher couldn't be arrested" for failing to appear.

To sum up the whole matter the trouble lies with parents not children. A teacher fitted for his work and *fit* for work will make friends of his pupils quickly if home influence be for him, or even if it be not actively against him; and once on friendly footing, school work goes smoothly, pleasantly and profitably.

It is a pleasure to be able to record that occasionally may be found a section which appreciates and pays a good teacher; the former fully, the latter cheerfully, not even referring to "vacations," and, in such a section, are sure to be found pupils eager for improvement, attending school regularly, doing home work and begging for extra instruction out of school-hours, and the teacher freely gives his time and his energies to his work.

In considering the subject of country schools, the average school-house and grounds might be mentioned.

Comfortable accommodations are obligatory and are being gradually provided; far less tumble-down school-houses, having all Canada for a play ground, are to be seen now than five years ago. But there is a lingering tendency to patch up the old dilapidated house and to utilize mud holes by enclosing them and *dubbing* them play-grounds. It is hard to root out at once the feeling that money invested in attractive school-houses, grounds and furnishings is wasted.

There is more or less of immutability as a fixed principle in the nature of man, else the inhabitant of the East in this nineteenth century would not plow and thresh with the primitive implements in use in the days of the Patriarchs, and we of the Western World are akin, and so long as one of those who fought the Free School system remains not gathered to his fathers, so long will teachers be grumblingly employed, grudgingly paid, and old school-houses remain until decay or the law stamps them out. However, a change for the better is certainly taking place, and in the golden age, as discerned in the dim future, teaching will become what it should be, a labor of love, even in the country school.

SECOND CLASS AND INTERMEDIATE—ENGLISH GRAMMAR.

July, 1879.

I. Make improvements in the following sentences where necessary :—

(*a.*) "A word before is worth two behind," should be "A word before is worth two after," because *behind* is a correlative of *before*, only when it refers to position. When the reference is to time, as here, the correlative of *before* is *after*.

"It is proved in the first book and "twenty-ninth proposition that when a "straight line falls on two parallel "straight lines it makes the alternative "angles equal."

(*b*). "It is proved in the twenty-ninth proposition of the first book that if a straight line fall upon two parallel straight lines it makes the alternate angles equal to each other."

(*c*). "I don't know as I can give it in the words of the book." I don't know that, &c, or better, I am not sure that, &c.

"Perseverance is indisputable to "success."

(*a*). "Perseverence is indispensable to success," not *indisputable* to success." The fault consists in using a word out of its accepted signification. It is an offence against lexicography, and is called an "impropriety."

(*e*). "Many of our readers are probably familiar with the Britannia Tubular Bridge which spans the Menai." "Probably many of our readers are familiar (well acquainted) with the Britannia Tubular Bridge, which spans the Menai."

(*f*). Let $\frac{a}{b}$ equal to x," should be

Let $\frac{a}{b}$ be equal to x, or Let $\frac{a}{b}$ equal x. The verb 'equal' governs an accusative. The adjective, equal, governs the dative.

(*g*). "A teacher should encourage cleanliness by all the means in his power, and if he sees that diseases are concealed by the hair or clothing, or that attempts are made to do so, he should see the parents about it," should be "A teacher should promote the habit of cleanliness by every means in his power; and if he finds that diseases are concealed, or attempted to be concealed by the hair or the clothing of the children, he should see their parents about it."

(*h*). "The temperature is not gradual." "The temperature is not uniform," or graduated according to meaning intended to be conveyed by "gradual."

(*i*.) "Among the advantages of using steam for warming a building may be reckoned the more equitable distribution of heat." The fault consists in using equitable for equable. See above (*d*.)

II. Should a meeting of the members of a Church for purposes of enjoyment be called a social or a sociable? Give reasons for your answer.

Such meetings should be called *sociables*. Social means *pertaining to society*, or companionship, sociable means *inclined to society*, man is a *social* being, but all men are not sociable. We may have a social gathering that is not a sociable gathering. *Social* is not so expressive of friendly intercourse as *sociable*. Social, however, is sanctioned by use, and is shorter.

III. Explain clearly what you mean by the term indirect object. Point out the indirect objects in the following sentences, and parse all the words in the objective case which are neither "direct nor indirect objects."

The indirect object of a verb is the word or phrase that answers to the question "For, or to whom?" "For, or to what?" when asked after the verb and its direct object.

It is always placed before the direct object, and if placed after the direct object a preposition must be inserted, in which case it is no longer the indirect object of the verb, but becomes the object of the preposition. When active verbs that take two objects are changed into the passive voice, one object becomes the subject of the passive verb, and the other remains in the objective case and is called the *Retained Object*.

In early English this indirect object had a special inflection, being mostly used after verbs that denote "giving" or "not giving." This Use or Case of the noun or pronoun was called the Dative Case.

IV. (*a*). "He made him a coat." In this sentence whether *him* is the short form of the reflexive pronoun "*himself*" or the objective of "*he*" it is the indirect object of the verb *made*.

(*b*). 'He made him king." Here, as above, "*him*" may be either in the objective or the short reflexive form. There is no indirect object in this sentence. *Him* is the object of the verb *made* completed by *king*. *King* is the "supplement of the incomplete verb" *made*.

(*c*). "He ordered them to hang the rascal." *Them* is the indirect object of *ordered*. "*To hang the rascal*" is the direct object of *ordered*.

(*d*). He ordered the rascal to be hanged. The phrase, "*the rascal to be hanged*" is the direct object of the verb *ordered*. Rascal is partly the object of the verb *ordered* and partly the subject of "*to be hanged*."

(*e*). "Let us not forget this." The object of *let* is "*us not forget this*."

(*f*). "I saw him run." The object of the verb *saw*, is *him run*.

(*g*). "The master taught the boys Latin." *Latin* is the direct object, and

boys is the indirect object of the verb *taught*.

(*h*). "He fought a battle." *Battle* is the cognate object of the verb *fought*.

(*i*). "He ran a mile." *Mile* is the adverbial object of distance.

(*j*). "It measures a mile." *Mile* is the adverbial object of degree.

V. Point out the ambiguity in the following sentence :—

(*a*). "He measures six feet," may mean, (1) when measures is passive; he is six feet high, or (2) *measures* may attribute to him the action of measuring six feet.

(*b*), "He thinks he is beaten," may mean (1.) He thinks he is overcome, or (2.) He thinks a beating is being inflicted on him, or (3.) He thinks he (another) is beaten, or (4.) He thinks he (himself) is beaten.

(*c*). "The Duke yet lives that Henry shall depose," means either. "The Duke that shall depose Henry yet lives, or, "The Duke that Henry shall depose yet lives." This sentence was purposely made ambiguous by Shakespeare. It is a good instance of the value of the rules of collocation.

(*d*). "Just at this moment I met a man who seemed a suspicious sort of fellow and turned down a lane," contains ambiguity as to what pronoun should be understood as subject to the last proposition, (he, or, I) "turned down a lane." There is also a double meaning in *suspicious*, active and passive, though the passive is the probable meaning intended.

(*e*). "I am not bound to receive any messenger you may send" contains an ambiguous use of *any*, and may mean "I am not bound to receive whatever messenger you may send," or "I am not bound to receive a messenger you may send."

MATHEMATICS.

Solution to Problems in the May Number.

35. If $ax+by=1$ and $cx+dy=1$,

$$\therefore x=\frac{b-d}{bc-ad}, y=\frac{c-a}{bc-ad}$$

$$\therefore \frac{(bc-ad)^2}{(b-d)(c-a)}=\frac{1}{xy}=ad+bc$$

$\therefore (ad+bc)(b-d)(c-a)=(bc-ad)^2$

multiply out and divide thro' by $abcd$, and we obtain

$$\frac{a}{c}+\frac{c}{a}+\frac{b}{d}+\frac{d}{b}=4.$$

36 Take a line AB to indicate the course, the stream flowing from A to B. If he goes down stream first he will reach B and start back to A before half his time has elapsed. Let C be his position at the end of half the time, that is, when he changes his rate of moving from 5 to 4½ miles per hour. Let D be a point farther up stream from which he can reach A in the same time that he took to row from A to B. Then, since his rate from A to B is 8 miles an hour, and from D to A 1½, and since these distances are rowed in the same time, it follows that DA is to AB as 1½ is to 8. Also, since the time of rowing from C to D is equal to the time from B to C, and that the rate from B to C is 2 miles an hour, and from C to D 1½, therefore BC is $\frac{4}{7}$ of BD, and hence is $\frac{12}{28}$ of AB. If he goes up stream first it may be shown in the same way that he will have gone $\frac{24}{33}$ of the distance from B to A when he reduces his rate of rowing. Now, suppose the length of the

course to be 140 miles (L. C. M. of 28 and 35). Then, in the first case, he goes 140 miles at 8 miles an hour, 65 at 2 and 75 at 1½ m. an hour, making the whole time 100 hours. In the second case he goes 96 miles at 2 m. an hour, 44 at 1½ and 140 at 7½ m. an hour, making the whole time in this case 96 hours, or 4 hours less than before. But the difference in time is only one hour, so that we have supposed the course four times too long, consequently the length of the course is 35 miles and the shortest time 24 hours.

37. If $f(x)$ be divided by $(x-a)(x-b)$ there will be a quotient (Q suppose) and a remainder of the form $cx+d$

$$\therefore \frac{f(x)}{(x-a)(x-b)} = Q + \frac{cx+d}{(x-a)(x-b)}$$

$$\therefore \frac{f(x)}{x-a} = Q(x-b) + \frac{cx+d}{x-a}$$

$$= Q(x-b) + c + \frac{ca+d}{x-a}$$

that is, the remainder, after dividing $f(x)$ by $x-a$ is $ca+d$,

$$\therefore ca+d = R$$

Similarly $cb+d = S$

$$\text{whence } c = \frac{R-S}{a-b}, \quad d = \frac{Sa-Rb}{a-b}$$

$$\therefore cx+d = \frac{R-S}{a-b}x + \frac{Sa-Rb}{a-b}$$

38. Suppose the green is worth 99c. and the black 77c. per lb. Then, if they are mixed in the ratio of 5 of green to 2 of black, one pound of the mixture is worth

$$\tfrac{5}{7} \text{ of } 99 + \tfrac{2}{7} \text{ of } 77 = 92\tfrac{5}{7}.$$

Now, since he intends to increase his selling price from 110 to 121, that is from 10 to 11, without changing the selling price per lb., he must reduce the value of each lb. sold from 11 to 10, that is to $\frac{10}{11}$ of $92\frac{5}{7}$c., which $= 84\frac{2}{7}$c. He has therefore to mix tea worth 99c. with tea worth 77c., so as to form a mixture worth $84\frac{2}{7}$c. per lb. Hence he must take 51 lbs. of green tea and 103 of black.

Or thus:

Take 770 lbs. of green and 308 of black. This is worth 1298 lbs. of black, and we require a mixture containing the same number of lbs. and worth 1180 of black. If 7 lbs. of black be substituted for 7 of green, the value of the mixture will be reduced by 2 of black, hence to reduce the value by 118 we must take out 59×7 of green and replace by 59×7 of black; we shall then have 357 of green and 721 of black: these are in the ratio 51:103. It will be noticed that 770 and 308 are as 5:2 and are multiples of 2, 7 and 11.

39. $2x\sqrt{1-x^4} = a(1+x^4)$

Square and divide by a^2x^4; then

$$\frac{4}{a^2x^2} - \frac{4x^2}{a^2} = \frac{1}{x^4} + 2 + x^4$$

$$\therefore \left(x^2 - \frac{1}{x^2}\right)^2 + \frac{4}{a^2}\left(x^2 - \frac{1}{x^2}\right) + 4 = 0$$

$$\therefore x^2 - \frac{1}{x^2} = -\frac{2}{a^2}\left(1 \mp \sqrt{1-a^2}\right)$$

$$= 2k^2 \text{ suppose}$$

$$\therefore x = \pm\sqrt{\left(k^2 \pm \sqrt{1+k^4}\right)}$$

$$= \pm\frac{1}{a}\sqrt{\left\{(\sqrt{1+a^2}-1)(\sqrt{1-a^2}+1)\right\}}$$

40. The one reaches its destination in 25 minutes and the other in 100 minutes after they meet, and since these numbers are in the ratio of 1:4, therefore the rates of the trains are as 1:2; and the distances they have gone when they meet must be in the same ratio, therefore the faster train runs the remaining one-third of the distance in 25 minutes, and consequently the whole distance in 75 minutes; therefore the trains started at 11hr. 35'.

41. It will be seen that B walks the same distance each day, namely: $\frac{1}{n+1}$ of the whole distance, and therefore in n days he will have gone $\frac{n}{n+1}$ of the whole distance. He could complete the journey in one day more.

A walks one-half the distance the first day, one-sixth the distance the second day, one-twelfth the third day, one-twentieth, one-thirtieth, &c., the fourth, fifth, &c., days We have therefore to sum the series.

$\frac{1}{2} + \frac{1}{6} + \frac{1}{12} + \frac{1}{20} + \frac{1}{30}$ &c. to n terms.

$$= \frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \text{\&c.} + \frac{1}{n(n+1)}$$

$$= 1 - \frac{1}{2} + \frac{1}{2} - \frac{1}{3} + \frac{1}{3} - \frac{1}{4} + \text{\&c.}$$

$$= 1 - \frac{1}{n+1} = \frac{n}{n+1}$$

And since A after walking n days leaves $\frac{1}{n+1}$ of the journey unfinished it follows that he can never complete it.

42. $2 \sin (A-B) \cos (A+B) = \sin 2A - \sin 2B$

$2 \sin (B-C) \cos (B+C) = \sin 2B - \sin 2C$. &c., = &c.

$2 \sin (N-A) \text{ as } (N+A) = \sin 2N - \sin 2A$

$\therefore$ by addition we have

$\sin (A-B \cos (A+B) + \text{\&c.}$

$+ \sin (N-A) \cos (N+A) = 0.$

43. After the contents of the first vessel are distributed, each of the remaining vessels contains a $(1+\frac{1}{n})$. After the second vessel has been distributed each of the remaining (undistributed) vessels contains a $(1+\frac{1}{n})^2$. After the r^{th} vessel has been distributed the $r+1$th vessel contains $a(1+\frac{1}{n})^r$, and the r^{th} vessel is now empty. This vessel therefore receives $\frac{1}{n}$ of the quantities.

$a(1+\frac{1}{n})^r$, $a(1+\frac{1}{n})^{r+1}$, &c. $a(1+\frac{1}{n})^n$

and will therefore contain finally

$$\frac{a}{n}\left(1+\frac{1}{n}\right)^r \left\{1+1+\frac{1}{n}+\left(1+\frac{1}{n}\right)^2+\text{\&c}+\left(1+\frac{1}{n}\right)^{n-r}\right\}$$

$$= \frac{a}{n}\left(1+\frac{1}{n}\right)^r \left\{\frac{(1+\frac{1}{n})^{n-r+1}-1}{1+\frac{1}{n}-1}\right\}$$

$$= a\left(1-\frac{1}{n}\right)^r \left\{\left(1+\frac{1}{n}\right)^{n-r+1}-1\right\}$$

44. We have $a+c=2b$, $x+z=2y$

$$axc = b^2 y^2, \quad \frac{a}{x}+\frac{c}{z}=\frac{2b}{y}$$

$$\therefore \frac{x}{y}+\frac{z}{y}=2, \quad \frac{x}{y}\cdot\frac{z}{y}=\frac{b^2}{ac}$$

$$\therefore \frac{x}{y}=1+\sqrt{\frac{ac-b^2}{ac}}, \quad \frac{z}{y}=1-\sqrt{\frac{ac-b^2}{ac}}$$

Again $\frac{a}{x}+\frac{c}{z}=\frac{2b}{y}=\frac{a}{y}+\frac{c}{y}$

$$\therefore a\left(\frac{1}{x}-\frac{1}{y}\right)=c\left(\frac{1}{y}-\frac{1}{z}\right)$$

$$\therefore \frac{a}{c}=\frac{1-\frac{y}{z}}{\frac{y}{x}-1}=\frac{1+\sqrt{\frac{ac-b^2}{ac}}}{1-\sqrt{\frac{ac-b^2}{ac}}}$$

$$\therefore \frac{a-c}{a+c}=\sqrt{\frac{ac-b^2}{ac}}$$

$$\therefore \frac{a-c}{2b}=\sqrt{\frac{ac-b^2}{ac}}$$

$$\therefore \left(\frac{a-c}{2b}\right)^2\left(\frac{ac-b^2}{ac}\right)=\left(\frac{ac-b^2}{ac}\right)^2$$

$$\therefore (a-c)^2\frac{b^2}{ac}=4\frac{b^2-2b_1ac+a_2c_2}{a^2c_2}$$

$$\therefore b^2ac(a-c)^2=4b(a^2c-b^2)(b^2-ac^2)$$

$$\therefore \frac{b_2a^2c-b^2ac^2}{(a^2c-b^2)(b^2-ac^2)}=\frac{4b}{a-c}$$

$$\therefore \frac{a^2c}{a^2c-b^2}+\frac{ac^2}{b^2-ac^2}=\frac{4b}{a-c}$$

$$\therefore \frac{a_2c-b^2}{a^2c}, \frac{a-c}{2b}, \frac{b^2-ac^2}{ac^2},$$

are in H. P.

TRIGONOMETRY.

University of Toronto.—First Examination, 1880.

Examiner: CHARLES CARPMAEL, M.A.

1. Define the logarithm of a number, and explain what is meant by the "base" of a system of logarithms.

Show that $\log. \frac{a^n}{b^m} = n \log. a - m \log. b.$

Find log. 175, and log. 6860.

Of what numbers are, 2, 0, $\bar{3}$, 0·25 the common logarithms?

2. Find the logarithm of, the square root of $\frac{\sqrt{3} \cdot \sqrt[3]{577}}{49 \cdot \sqrt{686}}$, and of $\frac{\sqrt{\cdot 002}}{\sqrt[3]{\cdot 07}}$.

3. Define the terms sine, cosine, and tangent, and make a table of their variations in magnitude and algebraic sign from 0 to 180°.

Having given the tangent of an angle, find the sine and cosine.

4. Find the sine, cosine, and secant of 30 and 45°.

5. If ABC be a triangle, right-angled at C, show how to find any of the quantities B, a, b, if A, c are given.

6. Prove that

$\sin (A \pm B) = \sin A \cos B \pm \cos A \sin B.$

$\sin 3A = 3 \sin A - 4 \sin^3 A.$

7. Prove the following formulæ:

$$\cos \theta = \frac{1 - \tan^2 \frac{\theta}{2}}{1 + \tan^2 \frac{\theta}{2}}$$

$$\sin 45° + \theta \sin 45° - \theta = \tfrac{1}{2} \cos 2\theta.$$

$$\sin 2\theta - \sin 2\alpha = \sin (\theta + \alpha) \sin (\theta - \alpha)$$

$$\frac{\sin \theta + \sin 3\theta}{\cos \theta + \cos 3\theta} = \tan 2\theta. \quad \tan 67° 30' = 1 + \sqrt{2}.$$

8. In any triangle, prove

(i) $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

(ii) $\cos \frac{A}{2} = \sqrt{\frac{s(s-a)}{bc}}$

9. Solve completely the triangles:

(i) $\cos \alpha = 1263$, $b = 1359$, $c = 1468$.

(ii) $A = 67° 59'$, $a = 2045$, $b = 2000$.

10. Find the areas of the triangles in question 9.

11. The elevations of a tower is found to be 45°, and on retiring 60 yards it is 30°, find the height of the tower.

No.	Log.
12630	·10140
13590	·13322
14680	·16673
14948	·17458
16124	·20747
20000	·30103

No.	Log.
20450	·31069
30000	·47712
57700	·76118
68600	·83632
70000	·84510
78200	·89321
79561	·90070

Angle.	L. Sin.
46° 58′	9·86389
52° 54′	9·90178
59° 7′	9·93360
65° 3′	9·95745
67° 59′	9·96711

ARITHMETIC AND ALGEBRA.

Examiner: F. HAYTER, B.A.

1. Enumerate the points of difference between algebra and arithmetic.

2. Given $a = 3$, $b = 4$, $c = -5$, find the value of $(3a + 4b + 5c)^2 + (4a + 3b + 12c)^2 - (5x + 5y + 13z)^2$

Given $a = 2$, $b = 1$, $c = 0$, find the value of

$$\left(\frac{b}{a} + \frac{c}{b} + \frac{a}{c}\right) \div \left(\frac{b}{a} + \frac{c}{b} + \frac{a}{c}\right)$$

3. Simplify

(1) $\left[a - 5b - \left\{a - (5c - 2c - b - 4b) + 2a - (a - 2b + c)\right\}\right]$

(2) $a - 2\left[b + 3\left\{a - 2(b - c) + 2b - 3(a - b + 2c)\right\}\right]$

4. Find the value of

(1) $$\frac{1 + 2x}{(3 - x)(1 + x)} + \frac{7}{(2 + x)(1 - 3x)} + \frac{x}{(1 + x)(2 + x)}$$

(2) $$\frac{1 - x}{1 + x} + \frac{1 - x - x^2}{1 + x + x^2} + \frac{1 - x - x^2 - x^3}{1 + x + x^2 + x^3}$$

(3) $$\frac{x^{3n}}{x^n - 1} - \frac{x^{2n}}{x^n + 1} - \frac{1}{x^n - 1} + \frac{1}{x^n + 1}$$

5. Describe Horner's method of division.

Divide according to Horner's method:

$4x^5 - 7x^4 + 25x^3 - 15x^2 + 8x + 10$ by $x^2 - x + 5$

$6a^4 - a^3b + 2a^2b^2 + 13ab^3 + 4b^4$ by $2a^2 - 3ab + 4b^2$

6. Prove the rule for finding the least common multiple of two quantities.

Find L. C. M. of $21x^2 - 26x + 8$ and $7x^3 - 4x^2 - 21x + 12$.

7. Solve

(1) $$(12 + x)^{\frac{1}{2}} = 2 + x^{\frac{1}{2}}$$

(2) $$\frac{x}{2} - \frac{\frac{1}{2}(2x - 3) - \frac{1}{4}(3x - 1)}{\frac{1}{2}(x - 1)} = \frac{3}{2}\left(\frac{x^2 + 2}{3x - 2}\right)$$

(3) $$\frac{66x + 1}{1{\cdot}5x + 1} \div \frac{4x + 5}{{\cdot}5x - 1} = 52$$

(4) $$\frac{\sqrt{a} - \sqrt{a - \sqrt{a^2 - ax}}}{\sqrt{a} + \sqrt{a - \sqrt{a^2 - ax}}} = b.$$

8. Find the fraction which, if 1 be added to its numerator, becomes $\frac{1}{3}$; but if one be added to its denominator becomes $\frac{1}{4}$.

Two persons A and B could finish a work in m days: they worked together n days when A was called off, and B finished it in p days. In what time could each do it?

9. Solve

1. $$\left(x + 22\right)^{\frac{1}{3}} - \left(x + 3\right)^{\frac{1}{3}} = 1$$

2. $$\frac{(a - x)^4 - (x - b)^4}{(a - x) - (x - b)} = \frac{(a - b)c}{(a - x)(x - b)}$$

3. $$\begin{cases} x + y + xy = 11 \\ x^2y + xy^2 = 30 \end{cases}$$

4. $$\begin{cases} x^{\frac{3}{4}} + y^{\frac{3}{5}} = 126 \\ x^{\frac{1}{4}} + y^{\frac{1}{5}} = 6 \end{cases}$$

10. The sum of two numbers added to the sum of their squares is 42, and their product is 15. Find the numbers.

If \$300 be laid out at simple interest for a certain number of years, it will amount to \$360. If the same be allowed to remain two years longer, and at a rate of interest one per cent. higher, it will amount to \$405. Find the rate and number of years.

11. Give the first term, common ratio, and number of terms in a geometrical progression, find the sum.

If a, b, c be in G. P. Prove

$$(a^2 + b^2 + c^2) > (a - b + c)^2$$

EUCLID.

Examiner, A. K. BLAKADAR, B. A.

1. Any two sides of a triangle are together greater than the third side.

If a point be taken within a parallelogram, the sum of its perpendicular distances from the sides of the parallelogram is less than the sum of the diagonals.

2. If the side of any triangle be produced, the exterior angle is equal to the two interior and opposite angles, and the three interior angles of every triangle are together equal to two right angles.

From the base BA, or BA produced, of the isosceles triangle ABC, BD is cut off equal to the side BC; from DC, DE is cut off equal to BC; prove that the angle DCA is double of the angle CBE.

3. Triangles upon equal bases, and between the same parallels, are equal to one another.

The angle BCA of the triangle ABC is bisected by the straight line CE which meets AB in E; CA is produced to D so that AD is equal to BC; prove that the triangle CED is equal to the triangle ABC.

4. If a straight line be bisected, and produced to any point, the rectangle contained by the whole line thus produced, and the part of it produced, together with the square on half the line bisected, is equal to the square on the straight line which is made up of the half and the part produced.

Produce a given line so that twice the rectangle contained by the whole line produced and the part produced may be equal to the square on the given line.

5. The angles in the same segment of a circle are equal to one another.

ABC is a triangle in the circle ABC; AOD is drawn from A bisecting the arc BC in D and meeting the side BC in O; prove that DB is a tangent to the circle through A, O, B.

6. If two straight lines cut one another within a circle, the rectangle contained by the segments of one of them shall be equal to the rectangle contained by the segments of the other.

Two circles with centres C and E touch each other internally at the point A; from the centre C of the smaller circle, CB is drawn at right angles to CE meeting the circumference of the larger circle in B; and from E the centre of the larger circle ED is drawn parallel to CB meeting the circumference of the small circle in D; prove that the straight line AB is equal to straight line AD.

7. To describe a circle about a given triangle.

O is the centre of the circle inscribed in the triangle ABC, circles are described about the triangles BOC, COA, AOB, having as centres A', B', C', respectively; prove that

$$AO.OA' = BO.OB' = CO.OC'.$$

8. Define *similar rectilineal figures* and *reciprocal triangles*.

ACB, ADB are two triangles upon the same base AB and between the same parallels; AD and BC meet in O; show that AOB, COD are *similar* triangles and COA, DOB are *reciprocal* triangles. Also, if EOF be drawn through O parallel to AB, show that the quadrilaterals $CDOE$, $CDOF$ are equal.

9. In a right angled triangle, if a perpendicular be drawn from the right angle to the base, the triangles on each side of it are similar to the whole triangle, and to one another.

Construct a right angled triangle, having given the hypotenuse and the difference of the squares on the two sides.

10. In equal circles, angles, whether at the centres or at the circumferences, have to one another the same ratio as the arcs on which they stand.

CHEMISTRY.

FIRST CLASS.

Q. 1. (*a*.) State the laws of chemical combination by volume and by weight. (*b*). Define the terms empirical, molecular and constitutional formulæ; simple and compound radicle.

(*a*). (1). Law of Constant Proportion. The same substance always consists of the same elements united in the same proportions.

(2). Law of Multiple Proportion. When one body combines with another in several proportions the higher proportions are multiples of the first or lowest.

(3). Law of Reciprocal Proportion.—If two bodies combine with a third, the proportions in which they combine with that third body are measures or multiples of the proportions in which they may combine with each other.

(4). Law of Compound Proportion.—The combining proportion of a compound is the sum or a multiple of the sum of the combining proportions of its constituents.

These laws respecting the constancy of weight with which the elements combine, apply with equal force to combination by volume. It was Gay Lussac who in 1809 established the truth of this, at least for such elements as exist in or can be made to assume the gaseous condition. The reasonings of Avogadro and Ampere in 1811 and 1814 upon the laws of Mariotte and Charles (that all gases are similarly affected by variations of pressure and temperature) have lead to the following deduction: "If EQUAL VOLUMES of gases be taken under like conditions, each will contain the SAME NUMBER OF MOLECULES, SIMILAR in SIZE and equally DISTANT APART." The experiments of Gay Lussac as well as the reasoning of Avogadro have given to Dalton's theory of atoms its chief support.

(*b*). An Empirical formula is an arrangement of symbols which merely gives the relative number of atoms in a substance, and is deduced from the analysis of the substance represented.

A molecular formula is an arrangement of symbols, representing the smallest particle of a simple or compound substance capable of existing in a free state.

A constitutional formula is a combination of symbols so arranged as to indicate the relative position of the elements or radicles composing the molecule, and how these may be replaced by other elements or radicles.

A simple radicle is any element which forms the basis or common ingredient of a series of compounds.

A compound radicle is a group of two or more elements in chemical combination which acts in many respects as an elementary body.

Q.—2. How would you proceed to calculate empirical formulæ from percentage composition? (*b*). The analysis of a compound leads to these numbers: Carbon = 37·20, Hydrogen = 7·90, Chlorine = 54·95 What is the formula.

(*a*). Divide the percentage of each element present by its atomic weight, the resulting quotients will be proportional to the number of atoms of each element in the compound.

(*b*). $\frac{37.20}{12} = 3.1,\ \frac{7.9}{1} = 7.9,\ \frac{54.95}{35} = 1.547.$

∴ 2:5:1 are the proportions of the number of atoms in each. Hence C_2H_5Cl is the formula.

Q. 3. Give occurrence, preparation and properties (*a*) of Silicon, and (*b*) of Arsenic. (*c*) Describe briefly Marsh's test for Arsenic.

(*a*) 1. Silicon does not occur free in nature, but is combined with Oxygen to form Silicon dioxide or Silica, which exists nearly pure in

sand, sandstone, quartz and flint. It also occurs as a component of granite, and combined with metals and Oxygen to form silicates. It can be obtained in two allotropic forms, Amorphous and Crystalline.

(2). Potassic silico-fluoride when heated to redness in a glass tube with Sodium or Potassium, reacts thus –

$K_2 Si F_6 + 2 Na_2 = Si + 2 K F + 4 Na F$

the mass when cold is well washed with cold water and then with boiling water. Silicon will be left as a brown amorphous powder which is soft to the touch as blacklead and readily burns to SiO_2 when heated in Air or Oxygen.

(3). A *graphitoidal* Silicon can be prepared by strongly heating the brown amorphous powder out of contact with air, when it becomes denser and harder and no longer burns when heated in air; or by fusing aluminium with Potassic Silico-fluoride and boiling the mass with strong Hydric Chloride, when Silicon in the form of hexagonal scales is left undissolved.

(4). Crystalline Silicon is obtained by fusing Potassic Silico-fluoride and Sodium with granulated Zinc; on boiling the mass crystals of Silicon are found deposited on the Zinc, from which they are removed by solution in an acid. It is sufficiently hard to scratch glass, and can be fused at a very high temperature.

(b) Arsenic is found in the free state, but more frequently associated with Sulphur and Iron, Nickel or Cobalt.

(2) When the ores are roasted in a reverberatory furnace the Arsenic is volatilized and condenses as Arsenic Trioxide (As_2O_3) in the long flues attached to the furnace. The crude product is mixed with Charcoal, and when sufficiently heated the Trioxide volatilizes, and its vapors, in passing over the ignited Carbon, will part with their Oxygen:—

$$2As_2O_3 + C_6 = 6CO + As_4.$$

Arsenic is a steel gray, crystalline, brittle metal, having a density of 5.7. It conducts electricity slightly. At a low red heat it volatilizes as a colorless vapor, without undergoing fusion. When strongly heated in air, it burns with a bluish flame, forming As_2O_3. It forms an important alloy with Lead in the manufacture of shot. It unites directly with Chlorine and Iodine at ordinary temperatures, and with Sulphur, when gently heated.

(c) Introduce a small quantity of a solution of Arsenic Trioxide (As_2O_3) into a small hydrogen apparatus, in which Hydrogen is being evolved from dilute Hydric Sulphate by Zinc. As_2O_3 will lose its Oxygen, and have it replaced by Hydrogen, forming Hydric Arsenide. Pass the mixed gases through a small tube of hard glass, having a drawn out point, and light them at the end; into the flame put a cold porcelain cover, Arsenic will be deposited on the porcelain, owing to the decomposition of AsH_3. The process constitutes a very delicate test for the presence of Arsenic compounds containing Hydrogen.

Q.—4. Sketch the points of resemblance and difference of Chlorine, Bromine and Iodine, and of their Hydrogen compounds, *(a)* How would you detect the presence of a soluble Chloride, Iodide, and Fluoride, present singly in a liquid? *(b)* What takes place when Chlorine is passed into a cold solution of Potash (KOH)? *(c)* By slightly varying the conditions of the last experiment, what other body might be formed?

At ordinary temperature Chlorine, Bromine and Iodine are each physically different, being a gas, liquid, and solid, respectively Chlorine becomes a liquid at ordinary temperatures under a pressure of about four atmospheres. This liquid boils at– 60°C, and in presence of water exhibits great bleaching power as well as solubility.

Bromine boils at 63°C, is moderately soluble in water, and has bleaching power, though in a less degree than Chlorine; when cooled to —22° it solidifies.

Iodine, when heated to 107°C, becomes a liquid, and at 180°C a gas. It has no bleaching power, and is scarcely soluble in water.

The Atomic weight of Bromine (80) is nearly the arithmetical mean between those of Chlorine and Iodine.

Chlorine, Bromine and Iodine each combine with Hydrogen to form a heavy, colorless

gas, which fumes in air. Chlorine has a very strong affinity for Hydrogen, forming the very stable compound, Hydric Chloride: while Bromine unites with Hydrogen with far more difficulty to form HBr, which can be more easily decomposed than HCl. Iodine combines very imperfectly with Hydrogen to form the quite unstable compound, Hydric Iodide, which, if exposed to air, immediately decomposes.

(*a*). (1). Argentic Nitrate ($AgNO_3$) added to any solution containing a Chloride will give *a curdy precipitate* (AgCl) insoluble in boiling Hydric Nitrate but readily soluble in Ammonia.

(2). Heat the suspected liquid with Manganic Oxide (MnO_2) and Hydric Sulphate (H_2SO_4), when Chlorine gas will be evolved.

(1). An iodide may be detected by its action upon some starch paste moistened with a drop or two of Chlorine water.

(2). Argentic Nitrate produces *a pale yellow precipitate* of Argentic iodide, insoluble, both in *Hydric Nitrate* and *Ammonia*.

(3). Plumbic Acetate $Pb(C_2H_3O_2)_2$ gives *a bright yellow precipitate* of plumbic iodide.

(1). A Fluoride may be detected by mixing the liquid with Hydric Sulphate, and heating it, when Hydric Fluoride (HF) will be evolved which may be tested by its power of etching upon glass.

(*b*). The following reaction occurs:—

$$2KHO + Cl_2 = KCl + KClO + H_2O.$$

That is, a mixture of the Chloride and the Hypochlorite of the metal Potassium.

(*c*). Pass Chlorine to saturation into a strong solution of Caustic Potash (KOH), then boil the solution for some time.

1st. Potassic Hypochlorite is formed.

2nd. This salt is decomposed into a Chloride and Chlorate.

$$3KClO = 2KCl + KClO_3.$$

Q—"Give the principal Hydric Salts of Phosphorus, (*a*) How are they formed? (*b*) Give some of their distinguishing tests."

(1) H_3PO_3, Trihydric Phosphate, or Phosphorous Acid, is formed by adding H_2O to P_2O_3. It is a debasic acid, two atoms of Hydrogen being replaceable.

(2) H_3PO_4, Trihydric Phosphate, or Phosphoric Acid is formed if a solution of P_2O_5 in water, be boiled. This acid is an exceedingly definite body, is so stable that it is destitute of oxidizing power, and is not reducable by nascent Hydrogen. It may be made to crystallize. It is a tribasic acid, and is distinguished in solution by giving a yellow precipitate with $AgNO_3 = Ag_3PO_4$, also a white precipitate with Ammonia and Magnesium Sulphate = Ammonium Magnesium Phosphate $NH_4MgPO_4 + 6H_2O$.

(3) $H_4P_2O_7$, Pyrophosphoric Acid is formed if tribasic Phosphoric be heated for some time to 210°,

$$2H_3PO_4 = H_4P_2O_7 + H_2O.$$

It is a tetrabasic acid. *Tetrasodic Pyrophosphate*, $Na_4P_2O_7$, is formed by heating Hydrodisodic Phosphate to redness, $2Na_2HPO_4 = H_2O + Na_4P_2O_7$. This substance gives with $AgNO_3$ a White Precipitate $Ag_4P_2O_7$.

4. HPO_3 Metaphosphoric Acid is formed when P_2O_5 is brought into contact with H_2O $P_2O_5 + H_2O = 2HPO_3$ or by evaporating a solution of Trihydricphosphate and igniting the residue. The corresponding Sodic Salt is formed by heating the Microcosmic Salt $(Na\,NH_4)HPO_4$ when H_2O and NH_3 are driven off and $NaPO_3$ is left. This acid is Monobasic and may be distinguished by the gelatinous precipitate formed by $AgNO_3 = AgPO_3$.

5. H_3PO_2 Hypophosphorous Acid may be regarded as HPO_3 in which one atom of O has been replaced by two atoms of H, H PH_2O_2. The corresponding Sodic Salt $NaPH_2O_2$ is formed by adding P to a solution of Caustic Soda, thus: $3NaOH + 4P + 3H_2O = PH_3 + 3NaPH_2O_2$.

Q.—6. (*a*). Name the chief ores of iron. (*b*) How is the metal obtained from its ores? (*c*) What is the chemical difference between cast-iron, steel and wrought-iron?

(*a*). Magnetic iron ore (Fe_3O_4). Ferrous Carbonate ($FeCO_3$). Ferric Oxide or Hæmatite (Fe_2O_3). Ferric Sulphide (FeS_2).

(*b*), The greater part of the English iron of commerce is obtained from the *Ferrous Carbonate* $FeCO_3$. The ore is first roasted, during which process, Carbonic Acid is driven off, and *Ferric Oxide* is formed. The roasted ore mixed with a due proportion of limestone is then brought into the blast furnace in alternate layers with coal. A high temperature is maintained, by forcing air heated to between 300° and 400°, through pipes near the bottom of the furnace. The chemical changes seem to be as follows:—When the air meets the coal, a vivid combustion ensues, and the Carbonic Acid produced passing upwards, combines with more Carbon, forming Carbonic Oxide. This reduces the *Ferric Oxide*, forming metallic iron and Carbonic dioxide,

$$Fe_2O_3 + 3CO = 3CO_2 + 2Fe.$$

This metal run into channels of sand constitutes the cast-iron of commerce.

(*c*). 1. Cast-iron contains greater quantities of Carbon and other impurities than wrought-iron, is more fusible, much more brittle, and possesses a highly crystalline structure.

(2). Steel has less Carbon than that needed to form cast-iron, and is nearly free from all other impurities, is less fusible than cast-iron, but much more so than wrought-iron.

(3). Wrought-iron has no crystalline structure, and is nearly pure, as it contains very small quantities of Carbon, Silicon, Phosphorous or other impurities.

Q.—7. (*a*). Illustate by formula the difference between Ferrous and Ferric Salts, Cuprous and Cupric, Mercurous, and Mercuric, (*b*). How may they be distinguished. ?

Ferrous Salts are formed from Ferrous Oxide FeO in which iron acts as a dyad ($FeSO_4$, $FeCl_2$).

(*a*) Ferric Salts are formed from Ferric. Oxide, Fe_2O_3 in which the double atom of iron acts as a triad, $Fe_2(SO_4)3$, Fe_2Cl_6, &c.

Cuprous Salts are formed from Cuprous Oxide Cu_2O in which Copper acts as *a monad* or according to a structural formula.

$$\begin{matrix} Cu \\ | \\ Cu \end{matrix} \rangle O$$ in which one arm of each copper atom is satisfied by the mutual attraction of the copper atoms themselves.

The Cupric Salts are formed from Cupric Oxide CuO. In these Salts the dyad character of copper is seen, ($CuSO_4$ $CuCl_2$, &c.) The same explanation holds good for the Mercuric and Mercurous Salts. The Mercurous are more stable than the Cuprous Salts.

Ferrous Salts (corresponding to Ferrous Oxide, FeO) may be distinguished from Ferric Salts (corresponding to Ferric Oxide Fe_2O_3) by the following re-agents:

(1). KOH. (*a*). Ferrous Salts give out of contact with air a white precipitate, $Fe(OH)_2$ which, in contact with air, becomes first green then brown $FE(OH)_2$ is oxidized to F_2O_3 (*b*). Ferric Salts give a brown prec., $Fe_2(OH)_6$, which is stable. When heated, water is given out and F_2O_3 remains.

(2). NHHO. (*a*). Ferrous Salts give no precipitate with Ammonia if Ammonia Salts are present. (*b*). Ferric Salts are not so affected — $FE_2(OH)_6$ is always thrown down by NH_4HO.

(3). K_4FeCy_6 (Potassium Ferrocyanide). Ferrous Salts produce a white precipitate which rapidly becomes blue, owing to absorption of Oxygen. (*b*). Ferric Salts produce a deep blue precipitate of soluble Prussian Blue ($Fe_4K_2Cy_{12}$) insoluble in saline solutions, soluble in pure water, producing a deep blue color.

(4). K_3FeCy_6 (Potassium Ferricyanide) (*a*). Ferrous Salts give a deep blue precipitate of soluble Prussian Blue ($Fe_4K_3Cy_{12}$) (*b*.) Ferric Salts only give a brown coloration.

(5). KCyS. (Sulphocyanate of Potassium) causes the formation of ferric sulphocyanate, which is of a deep blood-red color. There is no corresponding ferrous sulphocyanate.

(6). Na_2Co_3. (*a*). Ferrous Salts give a white precipitate ($FeCo_3$) rapidly becoming

light green, bluish green, and after a long time red, through absorption of O and formation of ferric oxyhydrate. (*b*). Ferric Salts form no carbonate.

(7). H_2S. in alkaline solution, throws down in every case FeS as a black precip.

The Cupric Salts are easily distinguishable:

(1). H_2S in acidified Solution gives a black precipitate CuS.

(2). $\left.\begin{matrix}NH_4\\H\end{matrix}\right\}S$ the same prec. insoluble in excess.

(3). KOH gives a bright blue precipitate $Cu(OH)_2$ which, upon the application of heat, becomes black,

$(Cu(OH)_2 = CuO + H_2O)$.

(4). K_4FeCy_6 (Potassium Ferrocyanide) gives a reddish brown precipitate Cu_2FeCg_6

(5). Na_3AsO_3 (Trisodic Arsenite) forms a green precipitate, with a Cupric Salt=$CuH\,AsO_3$, known as Scheeles green, if solution be cautiously neutralized with an Alkali.

(6). $NH_4\left\{\begin{matrix}O\\H\end{matrix}\right.\left\{\begin{matrix}\text{forms a blue precipitate Cu}\\(HO)_2\end{matrix}\right.$ which is readily soluble in excess of reagent, forming a deep blue liquid $\left(\begin{matrix}NH_2Cu\\NH_4\end{matrix}\right\{\begin{matrix}SO_4\\\end{matrix}\Big)$

7. Na_2CO_3 gives a green precipitate and is a basic Salt $CuCO_3 + Cu(OH)_2$

Cuprous Salts are not stable, taking up Oxygen from the air and forming the corresponding Cupric Salts.

Cu_2Cl_2 has the property of absorbing large quantities of Carbonic Oxide gas.

The Mercuric Salts corresponding to Mercuric Oxide HgO or Mercuric Sulphide may be distinguished by the following tests:

(1) NH_4HO gives *a white precipitate*,

$HgCl_2 + 2NH_4HO = NH_2HgCl + NH_4Cl + 2H_2O$ $(Hg(NO_3)_2 = NH_2HgNO_3)$

(2) KI gives *a red precipitate*,

$2\,KI + HgCl_2 = HgI_2 + 2\,KCl$.

(3). KOH, gives *a yellow precipitate*,

$HgCl_2 + 2(KOH) = Hg(OH)_2 + 2\,KCl$, but the $Hg(OH)_2$ only exists for a moment, splitting up into H_2O and HgO.

(4). *HCl gives* no *precipitate!!!*

(5), A Mercurous Salt in acid solution gives with H_2S in the beginning *a white precipitate* $= HgCl_2 + HgS$, a double combination, on the addition of more H_2S *black HgS* is precipitated.

The Mercurous Salts corresponding to Mercurous Oxide Hg_2O or Sulphide Hg_2S, may be thus distinguished:—

(1). NH_4HO, gives $\left\{\begin{matrix}NH_2Hg_2Cl\\NH_2Hg_2NO_3\end{matrix}\right\}$ *a black precipitate.*

(2). KI, gives HgI, *a green precipitate.*

(3). KOH, gives $Hg_2(HO)_2 = Hg_2O + H_2O$, *a black precipitate.*

(4). HCl, gives Hg_2Cl_2 *a white precipitate.*

(5). When H_2S is added to an acidified solution of a Mercurous Salt, *a black precipitate immediately* falls.

Q.—8. How much $KClO_3$ is required to furnish enough Oxygen which, when brought into contact with sufficient Nitrogen Dioxide, will form 33 litres of Nitrogen Tetroxide, measured at —1°C and 780 m.m. pressure?

33 litres NO_2 at —1°C, and 780 m. m. pressure, become $(33\times\frac{2}{2}\frac{7}{7}\frac{3}{2}\times\frac{7}{7}\frac{8}{6})$ litres at 0°C and 76 m.m. pressure. But 11.2. litres of NO_2 at 0°C and 760 m. m. weigh 23 grammes, ∴ $(33\times\frac{3}{2}\frac{7}{7}\frac{3}{2}\times\frac{7}{7}\frac{8}{6}\times\frac{1}{1}\frac{0}{1}\frac{}{2}\times\frac{2}{1}\frac{3}{})$ grammes = 69.8. grammes = weight of required Nitrogen Tetroxide.

$NO + O = NO_2$

hence every 46 parts of NO_2 require 16 parts Oxygen, ∴ 69.8 grammes NO_2 require

$\frac{69.8\times16}{46} = 24.27$ grammes of Oxygen.

$2KCLO_3 = 2KCL + 3O_2$

hence, 245 parts $KCLO_3$ yield 96 parts of Oxygen, ∴ 24.27 grammes of Oxygen require

$\frac{24.27\times245}{96} = 61.93$ grammes of Potanic Chlorate.

Q.—9. (*a*). How would you separate Calcium, Barium and Magnesium in solution, (*b*) What decomposition do Silver Chloride

(AgCl), and Silver Nitrate, ($AgNo_3$) undergo in the light? (*c*) What weight of Mercury and Corrosive Sublimate must be taken to yield 3 Kilos of Calomel?

(*a*). To an aqueous solution in which Salts of all three are present, add

(1) K_2CrO_4 (yellow Chromate of Potassium,) Barium is precipitated as $BaCrO_4$. Filter and to the filtrate, add

HCl and $(NH_4)_2CO_3$ and boil $CaCO_3$ is precipitated. Filter and to filtrate, add

Na_3PO_4 Magnesium is precipitated, $Mg NH_4PO_4 + 6H_2O$.

(*b*). They are both gradually reduced to metallic silver (or sub Oxide Ag_4O ?)

(*c*). $HgCl_2 + Hg = Hg_2Cl_2$.

$HgCl_2 = 200 + 71 = 271$ parts of Corrosive Sublimate.

$Hg = 200$ parts of Mercury.

$Hg_2Cl_2 = 400 + 71 = 471$ parts of Calomel.

3 Kilos $= 1000 \times 3 = 3000$ grammes.

Hence, 471 grammes of Calomel require 200 grammes of Hg.

$\therefore$ 3000 grammes Calomel require

3000×200

$\frac{3000 \times 271}{471} = 1273.9$ grammes of Hg.

Similarly 3000 grammes Calomel require

$\frac{\qquad\qquad}{471} = 1726.1$ grammes of $HgCl_2$.

Q. 10. How much Oxygen is required to form 5 volumes of Ozone by means of a series of electric discharges passed through the gas.

12 vols. of Oxygen contract one volume in forming Ozone.

$\therefore$ 2 vols. of Ozone require 12 vols. of Oxygen, since 3 vols. of Oxygen condense to form 2 vols. of Ozone. Hence 5 vols. of Ozone require 30 vols. Oxygen.

UNIVERSITY OF TORONTO.—FIRST EXAMINATION, 1880.

ENGLISH, (*Pass.*)

Examination: FRED E. SEYMORE, M. A., J. H. LONG, M. A.,

1. Write a composition on one of the following subjects:

(1.) "An habitation giddy and unsure
Hath he that buildeth on the vulgar heart."—*Shake.*

(2.) "A French family settled in England and edited the England Language."—*Earle.*

(3.) "A drop of ink,
Falling like dew upon a thought, produces That which makes thousands, perhaps millions think."—*Byron.*

(4.) "Si vis me flere, dolendum est Primum ipsi tibi; tunc tua me infortunia lædent."—*Horace.*

2. Give the accidence of the English *noun*, tracing the history of its inflections, and explaining such anomalous forms as occur.

3. "The grammatical character of a word is only a habit, one actual habit out of many possible ones." *Earle*, p 190. Explain what is meant by this statement, and illustrate by examples from Shakespeare and from the English of to-day.

4. Give a list of those particles, initial or terminal, by which a noun is converted into a verb, with illustrations of their use, and some account of their derivation and history.

5. Explain and illustrate what Earle means by "the three adjections."

6 Explain the chronological relation subsisting between *accent* and *rhythm*. Show how English ryhthm was effected by the Norman Conquest.

7. Give an account of the principal writings of Thomas Sackville, note their literary characteristics and their influence upon the early English drama.

8. Give as full an account as you can of the writings of Beaumont and Fletcher, and point out their chief literary characteristics.

9. Enumerate and characterize the chief historical writers and historical works of the reign of James the First.

(*Honors.*)

1. "The strife between the Norman and Saxon forms of verse was not of long duration."

Enlarge upon and explain the above.

2. What was the object sought to be effected by the author in Pier's Plowman?

3. Brief notes on Sir Thomas Moore Bishop Latimer, Caxton, and Surrey.

4. (*a*) Write a paper upon the difference between the diction of prose and that of poetry.

(*b*) Classify, explain, and illustrate English metres.

5. "In etymology consonants count for very little, and vowels for nothing at all."

Enlarge upon, and illustrate this, referring to laws governing the transmutation of letters.

6. (*a*) Compare Shakespeare as a dramatist with great dramatists in other languages.

(*b*) Name, with explanatory notes, the various works of Chaucer.

7.

"A Merchaunt was ther with a forked berd,
In mottelaye and high on horse he sat,
Upon his heed a Flaundrisch bever hat,
His botus clapsud faire and fetously.
His resons he spok ful solemply,
Sownynge alway the encres of his wynnynge."

(*a*) Re-write in modern English.

(*b*) Brief notes on the terminations *-e* (faire), *-ly*, *-ynge* (sownynge).

(*c*) Give a synopsis of "The Nonne Preste, His Tale."

8. O serpent heart, hid with a flowering face!
Did ever dragon keep so fair a cave?
Beautiful tyrant, fiend angelical!
O Nature! What hadst though to do in hell,
When thou didst bower the spirit of a fiend
In mortal paradise of such sweet flesh?
Was ever book containing such vile matter
So fairly bound?

(*a*) Point out all figures of speech.

(*b*) Derive *serpent*, *dragon*, *fiend*, *angelical*, *hell*, *paradise*, *such*, *vile*.

(*c*) Who speaks and upon what occasion.

9. Where is the scene of Romeo and Juliet laid; and who are the chief persons in the drama.

COMPOSITION WRITING.

THE difficulties attending writing compositions are similar to those of a sportsman who tries to shoot an unloaded gun. The pupil is often expected to prepare a composition before he has the ingredients to compound. No person would expect a cook to make a pie or a cake, the cook's composition, without supplying the ingredients. If figs are not to be expected from thistles, much less are they from dry sticks.

Boys as well as men can say something when they have anything to say, and what they can *say* they can *write*. "First catch the hare," then serve it up.

The requirement of essays and compositions often leads to impositions and plagiarism, and no wonder, when

school children are compelled to present finished productions on such subjects as contentment, jealousy, and growing old gracefully, copied compositions of the oldest son or daughter are often made to serve for all the younger boys and girls of the family.

But how shall the ammunition wherewith to load the mental gun be obtained? Certainly by the observation of the pupil himself, and the testimony of other persons. In maturer years the results of reflection and reasoning will supplement the facts observed.

The writer of this once required compositions from a class unaccustomed to write them. Request after request came, even from pitying mothers, for their children to be excused "this time," so the announcement was made that all would be excused "this time," from composition who would hand in a written excuse stating the reasons why they wished to be excused. As may be supposed the writers of *excuses* were surprised when they found themselves credited with *compositions*. They found that they could write about what they could talk about.

To stimulate a habit of *observing* I would suggest that pupils be asked to notice and then write down, as many points of *resemblance* or of *difference* as they can see, or recollect having seen, or gain from conversation with others, or read in books, between different animals.

As a sample of what some have done and others may do, let us note some of the differences between horses and oxen, or more properly between *equine* and *bovine* animals.

To make the contrast more manifest put the points of difference as follows :

EQUINE.	BOVINE.
Have one toe.	Have two toes.
Never with horns.	Usually with horns.
Have a flowing mane.	Without a mane.
Pawing with the fore feet denotes hunger.	Pawing with fore feet denotes anger.
Tail covered with long coarse hair.	Long hair in a tuft at end of tail.
Seize grass with their lips and convey to their teeth in feeding.	Encircle food with the tongue and convey to mouth.
Lips very movable.	Lips slightly movable.
Have upper and lower front teeth.	Have no upper incisor teeth.
Lie down hind parts first.	Lie down fore parts first.
Rise on fore legs first.	Rise on hind legs first.
Mouth long. Space between front and back teeth.	Shorter mouth. No vacant space between incisor and molar teeth.
One stomach to hold about three gallons.	Four stomachs. (Tripe in one of them.)
Do not chew the cud.	Always chew the cud.
Intestines large—60 feet long.	Intestines small—120 feet long.
Have no gall bladder.	Have gall bladder.
Cannot vomit.	Can vomit.
Never breathe through the mouth.	Can breathe through the mouth.
Never open the mouth from exhaustion, but only to eat or bite.	Mouth usually open when wearied.
Defence by kicking.	Defence by hooking.
Neigh or whinney.	Bellow or moo.
Perspire easily.	Do not perspire easily, if ever.
No dew lap.	Have dew lap.
Hard oval warts inside hind legs.	No warts inside hind legs.

Use their teeth in fighting.	Never use teeth in fighting.
Retract the ears when angry.	Do not retract the ears.
Soft smooth tongue.	Very rough tongue.
Long narrow head.	Broad triangular head.
Erect narrow ears.	Wide ears.
Limbs formed for swiftness.	Limbs formed for strength.
Live thirty to forty years.	Live twelve to eighteen years.
Lie down and roll over.	Do not roll over.
Sleep with one ear forward.	Sleep with both ears alike.
Often sleep standing.	Seldom sleep standing.
Eat all or most of the time in pasture.	Eat a while and lie down to ruminate.
Shoulders slope back.	Shoulders forward.

Probably no *one* pupil will have all the points named, but in a school of twenty the number of differences might be much larger.

After getting all interested in the subject, the teacher might write on the blackboard all the real distinctions, which would make an excellent object lesson in Natural History, and stimulate his pupils to observe, so that when they attend the next menagerie, they will learn as well as laugh, and possibly get their money's worth, as well as they do at school. But the *composition* is not yet. The material is gathered, which should be common stock, and it should be woven together as skilfully, and expressed as clearly and concisely, as each one is able. It would be well for the writer to make two compositions, one on equine, and one on bovine animals, and read them to father or mother, to see if the subject matter is intelligible, for often what is plain to the writer is obscure to the reader.

Innumerable topics of similar scope will occur to teacher and pupil, as comparing or contrasting birds and fishes—humming birds and butterflies—sheep and goats, &c., &c. Remember, the points of agreement may be described as well as differences.

What, after all, is a composition, but elegant and clear expression in writing of what one knows and wishes the reader to know? Try this plan fellow-teachers, who neglect or dread the composition exercises.—*Communicated to the Educational Journal, of Virginia.*

HEALTH DEPARTMENT.

In the next number of THE SCHOOL MAGAZINE we purpose beginning a department of Hygiene, which will be conducted by Dr. Alexander Hamilton, M.A., of Port Hope. It will open with a series of articles on "*The Eye.*" The editor of this Department of the MAGAZINE brings to his work extensive and accurate scholarship acquired in the colleges of this country and of Europe, and a great amount of experience as a medical practitioner. The object we have in view in opening a health department is the earnest advocacy of reforms in the management of our schools, and in their accommodation and equipment; some of the evils to be remedied are want of proper ventilation and drainage, defective lighting of school rooms, length of school sessions, the almost total absence of physical education, and the unhealthy spirit of competition that pervades many of the schools of the provinces.

PERSONALIA.

Douglas Alexander, of the Fourth Form, Hamilton Collegiate Institute, matriculated at Osgoode Hall, at the last examination, for admission to the Law Society, and ranked *first*.

James Herrald, M.A., has been appointed Head Master of the Dundas High School, in place of D. C. Sullivan, LL.B., who has resigned in order to enter the field of journalism.

At the recent terminal examinations of McGill College, Montreal, Messrs. Harcourt Bull and C. H. Keays, both from Hamilton, graduated in Arts, with the highest honors: the former winning the gold medal, and the latter ranking first in proficiency.

R. R. Wallace, son of Dr. Wallace of the Hamilton Asylum, passed his second examination in medicine, Toronto University, and won the Scholarship.

Charles McDonald, who matriculated from the H. C. I. in 1877, in Toronto University in medicine, graduated at the last examination, We understand that Mr. Macdonald intends to continue his studies in the Hospitals of Europe.

The election of members of Senate, Toronto University, resulted in the return of A. G. Campbell, M. A., Barrister, Toronto; John King, M.A., Barrister, Berlin; and S. Woods, M.A., Kingston. Of the 42 members comprising the Senate, no fewer than 35 are residents of Toronto, 18 are lawyers, 6 doctors of medicine, and only 6, including college professors. are actively engaged in the work of education. The High Schools and Collegiate Institutes of the province that are now the main stay of the University, have but *one* representative.

Among those headmasters of High Schools who have been successful in their endeavors to add one more to the list of Collegiate Institutes, Mr. F. L. Michell, B. A., of Perth, deserves to be especially mentioned. Mr. Michell had two serious obstacles to work against, the school was not a first-class High School when he took charge of it, nor has he had the assistance of so large a staff of teachers as would make the existence of a Collegiate Institute probable. In spite of these, however, the Perth Collegiate Institute is now an accomplished fact. The Trustees should, however, increase the strength of the teaching staff if they wish the school to take its proper rank.

SCHOOL DISCIPLINE.—The following things aid in securing good discipline and preventing disorder: 1. See that the school-room is well warmed, ventilated, cleansed, and lighted, and adorned with pictures, mottoes, and flowers. 2. Give pupils plenty to do. 3. Approve work when well done. Carefully inspect the pupils' work. 5. Keep up an interest in work. 6. Few rules, uniformly executed. 7. Frequent changes of exercise. 8. Control by kindness. 9. Make the school and its exercises popular. 10. Pile on motives.

PUBLIC SCHOOL DEPARTMENT.

PROMOTION EXAMINATIONS.

We are glad to see that several of our County School Inspectors are making an effort to secure a uniformity of grade in the Schools of their respective Inspectorates. Quarterly promotion examinations are held, at the same hour, in every School in the County, each teacher being furnished by the Inspector with a copy of the questions to be used. The following are the papers used in the East Middlesex Promotion Examinations of April, 1880:

ARITHMETIC.

2nd to 3rd Class.—time 2 hours:—

1. (*a*). Add

8,000,410;
4,607,203;
20,305;
40,670,369:

(*b*). Add ten thousand and twelve; three hundred thousand and ninety; 9 thousand and seventy; 139 thousand and 7 hundred.

2. From one million subtract 195,789 again and again, until the remainder becomes less than the subtrahend.

3. Multiply 320,070 by 490,050.

4. How often is 197 contained in one million?

5. Willie has 51 marbles, Tom has 23 less than Willie, Ned has 41 more than Willie and Tom, Jack has twice as many as the other three; Jack lost 19, how many has he left?

6. The divisor is $375, the quotient is 23, the remainder $183, find the dividend.

7. Using factors, divide 53706359 by 144. (6 marks if you use 2 factors; 10 for three factors.)

8. Add $5689, $23, $12,897, and $4,029,017; take $1798 from the sum, and multiply the result by nineteen.

9. A farmer had 307 bushels of spring wheat, and 412 bushels of fall wheat last year; this year he has 509 bushels of oats and 314 bushels of fall wheat; how much would his wheat be worth for both years at an average price of one dollar and nine cents a bushel?

(Ten marks for each question. Accuracy and neatness before every other thing in this paper.)

3rd to 4th Class.—Time 2¼ hours.

Values	
12	1. A certain number is multiplied by 7, divided by 9, then 39 is added, when 43 is then subtracted half the remainder is 40, find the original number.
12	2. The quotient is 309, the remr. is three times the quotient: the dividend is 2.909, 235; find the divisor.
24	3 Express 278,597 acres in roods; 5½ rods in yds; 65 yds. 3 feet in rods; 207 bus 24 gal. 64 qts. of oats in pecks.
12	4. A lady purchased 14 yds. 3 qrs. silk @ $2.60 per yard, thus spending 8 cts. more than ¼ of her money. How much had she?

Values

12 5. In 271 tons 790 lbs. 48 oz. how many loads, each weighing 14 cwt. 79 lbs?

12 6 Add $\frac{2}{3}$ of $\frac{1}{5}$, $3\frac{1}{9}$, $28\frac{5}{18}$, $12\frac{7}{10}$, and $(3\frac{1}{2} - 2\frac{1}{12})$.

12 7. Bought soap at $2.00 per box containing 24 bars, how many boxes must I sell at the rate of 3 bars for 38 cents to gain $26.00.

18 8. 4,500 lbs of hay, @ $11.50 per ton; 1,700 lbs of wheat, @ $1.90 per cwt; 576 cbc ft. of wood, @ $3.50 per cord; find total.

4th to 5th Class.—Time 3 hours :—

Values

15 1. Add: $\frac{1}{6}\frac{1}{4}$ of a cwt., $\frac{1}{2}\frac{3}{5}\frac{3}{6}$ of a lb., $3\frac{1}{4}$ oz.; (Ans in decl. of a ton.)

15 2. Add:

$$\left\{ \frac{3\frac{1}{2} + 2.4}{\frac{1}{3} \text{ of } \frac{5}{11} \text{ of } (359.142857 + \frac{9}{33})} \right\}$$

of $2\frac{1}{2}$ miles + $\frac{1}{4}$ of $\frac{1}{5}$ of $\frac{1}{6}$ of $\frac{1}{3}$ of of $\frac{3}{5}$ of $\frac{5}{6}$ of .36 of $2\frac{1}{2}$ rods.

15 3. The numr. of a complex fr. is 3; it gives $\frac{5}{9}$ when divided by $7\frac{1}{2}$; find the denr.

15 4. The freight and duty on 1250 gallons was $120; the freight was $\frac{1}{5}$ of the duty; find the duty on $2\frac{1}{2}$ gallons.

15 5. A Grocer sells $15\frac{7}{8}$ oz. for 1 lb., how much did a customer lose who paid him $12.70 for sugar?

15 6. M bo't 125 gals. of wine at $1.75 per gal., 4 gals leaked out, he put in 9 gals of water and then sold the whole gaining $15.25; at what price per quart did he sell the wine.

15 7. A, B & C traded together; A put in $140, B $250 and C 120 yards of cloth; they gained $230 of which C's share was $100; find price per yard of C's cloth.

15 8. A train, 250 yards long running 30 miles an hour, passes another running in the same direction in 1 min. 20 sec. Find the rate of the second per hour. (Ans. in miles and fr. of a mile.)

30 9. 3565 lbs. of wheat @ $1.90 per cwt.; 712 lbs. of beef @ $5.12½ per cwt.; 1695 lbs of hay @ $11.20 per ton; a pile of wood 6 ft. high, 2½ ft. wide, 23 ft. long, at $3.15 per cord; and 19 two inch planks 14 ft. long, averaging 10 in. wide, at $8 per thousand.

15 10. Simple interest on $709.20 from 12th Oct., 1879 to Mar. 31st, 1880, @ 8½ per cent. per annum.

GEOGRAPHY.

3rd to 4th Class.—Time 1½ hours.

Values

6 1. Give the boundaries of the County of Middlesex.

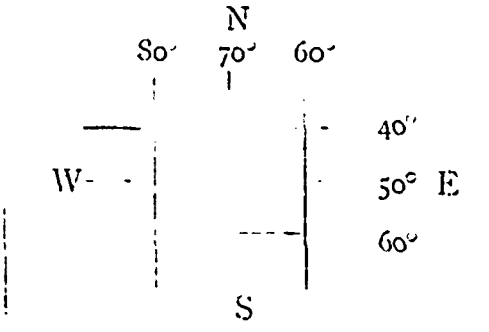
9 2. Name the rivers that flow through the County of Middlesex, telling which way they flow, and into what they empty.

33 3. Locate the following rivers, tell which direction they flow, and into what empty: Mackenzie, Saskatchewan, Albany, Hudson, St. Lawrence Mississippi, Orinoco, Amazon, Madeira, Rio Grande, LaPlata.

Values	
12	4. Name and locate the principal mountain ranges of North and South America.
15	5. Name and locate the principal Canadian lakes, and name the boundary lakes in order from the West.
14	6. What and where are: Cuba, Ungava, Hatteras, Yucatan, Biscay, Himalaya, Congo, Guiana, Baltic, Chaleur, Canso, Gaspe, Vancouver, Algoma.
16	7. Name, locate and give the county towns of the counties of Ontario, beginning with the letter "P."

4th to 5th Class.—Time 1½ hours.

Values	
24	1. Define plateau, prairie, glacier, watershed, climate, spring-tide, monsoon, snow-line.
12	2. Name in order the cities and chief towns through which you pass in travelling through Ontario by the G. T. R.
12	3. Name the townships, towns and incorporated villages in the county of Middlesex.
8	4. What are the chief exports of Middlesex.
26	5. Name, in order, the States and Territories of the United States on the North Boundary, telling what part of Canada or on what lake each borders.
18	6. Where and for what famous are Queenston Heights, Plains of Abraham, Burrard Inlet, Philadelphia, Manchester, Hastings, Balmoral, Malta and St. Helena.
32	7. Draw a map of Ontario, west of the county of Ontario. Mark the Thames and Grand rivers, and ten towns or cities having harbors.
8	8. Approximate as nearly as you can the part of the globe indicated by latitude and longitude



GRAMMAR.

3rd to 4th Class.—Time 1½ hours.

Values	
6	1. *(a)* When should we use the apostrophe without the "s" to mark the possessive case.
6	*(b)* Write the possessive plural of 'man,' 'child,' 'bear.'
20	2. Write sentences containing the word 'round' used as a noun, adjective, adverb, verb, preposition, respectively.
12	3. Write phrases instead of the italicised words in— "They lived *happily* together." "They were both young *then*, but they are old *now*." "He is an *honorable* man."
15	4. What is the difference between :— *(a)* An adjective and an adverb? *(b)* A preposition and a conjunction? *(c)* A common and a proper noun?

Values	
12	5. What part (state exactly) of the verb is :—to sit, sitting, sat'st and shall sit?
17	6. Give the principal parts of: go, mow, row, sow, stand, land, reap, weep, keep, set, pet.
16 28	7. Analyze :—Parse italicised words :— *Away went* Gilpin's *hat* and wig. There *came* to the beach a poor *exile* of Erin. James *can do* much *better*. *Run* faster.

4th to 5th Class.—Time 2 hours.

Values	
	1. Turn to page 50, (Fourth Reader "Breeze's.....to) than this?"
24	(*a*.) Analyze the extract.
13	(*b*). State the cases, giving reasons, of all the nouns and pronouns to "Texas," (commencing with "Breezes.")
	(*c*). Parse: pass, poised, yet, on high, have, played, from, than.
12	2. Write the plural corresponding to: phenomenon, no, I, "x," his, thee, wolf, eulogy.
24	3. Parse the phrases and clauses in the following as if they were expressed by single words: "They left in a hurry, having been sent for by their friends." "In a short time we shall be better prepared than at present to furnish you with a full account of what we have done."
	4. Give the principal parts of the strong verbs used in the sentences assigned for correction (No. 5.)
	5. Correct where necessary, giving your reasons in every case:
	(*a*). The following treatise, together with those that accompany it, were written many years ago.
	(*b*). It has taken man thousands of years to partly learn the laws of nature.
	(*c*). The Book of Psalms were written by David and others.
	(*d*). That building must be either a church or school.
	(*e*). He got assistance both from them and I.
	(*f*). His failure was on account of the people giving him too much credit.
	(*g*). I don't know as I'll go to-morrow.
	(*h*). I do not know but what I may go.

HISTORY.

4th to 5th Class—Time 1 hour.

Values	
16	1. What results still remain of the several invasions of the British Isles (55 B.C. to 1100 A.D.)
16	2. Write notes on: Joan of Arc, Warwick, Margaret of Anjou, Elizabeth of York.
18	3. "Money is necessary to govern a kingdom." How did the Stuarts, Cromwell, and William III. raise money respectively?
20	4. State the chief results of the revolution of 1688, and of the Canadian Rebellion of 1837.
10	5. Trace the rise and progress

Values

12 of the press. Write notes on "The North Briton," "London Times," "Toronto Globe" and the "Toronto Mail."

16 6. Write notes, giving at least one date in each case, on: Simon de Montford, Robert Bruce, the elder Pitt, and Wellington.

COMPOSITION.

3rd to 4th Class.—The teacher will read the short story "Observation," twice slowly and correctly, then allow three minutes for asking questions. The pupils will then be allowed 30 minutes to write;—no questions to be answered or book to be consulted after the writing commences. Value 60 marks.

Consider neatness, division into sentences and spelling.

4th to 5th Class.—Time 1½ hours.

Values

1. Write:

3 (*a*) A complex declarative sentence containing the word "concerning."

4 (*b*) A simple interrogative sentence containing "whether."

3 (*c*) An imperative sentence containing "from."

10 2. Punctuate, and put in capitals:—

have you ever read that after the battle of pavia in italy a d 1525 a battle that proved disastrous to the french francis 1st wrote to His mother all is Lost but honor

15 3. Write an advertisement for a "Strayed or stolen" cow.

10 4. Write a negotiable promissory note, bearing interest.

25 5. Write a letter, of not more than ten lines, refusing, as politely as you can, the application of a *friend* for the loan of fifty dollars.

30 6. Write a composition on "The winter of 1880." (Topics; weather, comparing with the weather of preceding winter, how it is likely to affect agriculture, public events, events connected with the school and neighborhood.)

SPELLING.

2nd to 3rd Class.—Value 100 marks. —3 off for every mistake.

Write and number the following words and phrases:

1. Whose lives were o'er.
2. He bought three pecks of barley meal.
3. Ann sings some pretty song.
4. Catching gnats.
5. The summer's scented clover.
6. They had caught a dreadful fever which was raging.
7. All dumb animals.
8. Burnt almonds and carraway comfits.
9. Wealth of luscious fruit.
10. After wringing the water from his hair.
11. A sincere friend.
12. Lord Mayor of London.
13. pane.
14. except.
15. lullaby.
16. fairy.
17. tongues.
18. mischief.
19. receive.
20. cushion.
21. assail.
22. ceaselessly.
23. tortoise.
24. sieve.
25. qualities.
26. descendants.
27. wain.

28. scissors.
29. epitaph.
30. ingenious..
31. truly.
32. separated.
33. breakfast.
34. daisy.

(give the meanings of the *words* as they are dictated.)

3rd to 4th Class.—Value 75 marks. $3\frac{1}{2}$ off for every mistake.

1. The varied elegance of the highly-scented blossoms.
2. Turned on his assailant in a moment of irritability.
3. The reptile was seen wriggling in his talons.
4. Pray, accept this little present.
5. One must do one's duty conscientiously.
6. Made of knotty tamarack wood.
7. On we hie with screech and roar.
8. Pemican is extensively used throughout Rupert's Land.
9. The schooner collided with the steamer.
10. His sword and sceptre, pageantry and pride.
11. recommendation.
12. proceeding.
13. preceding.
14. biscuit.
15. discerning.
16. indispensable.
17. inexpressible.
18. expense.
19. skilful.
20. pigeons.

4th to 5th Class.—Value 90 marks, 3 off for each mistake.

1. Sheltered coves and pebbly beaches. 2. Picturesque scenery. 3. Immense quantities of mackerel, crayfish, mussels, and sardines. 4 The sea beach leaves. 5. Too much occupied with civil dissensions. 6. Stretching indefinitely inland. 7. Accessions from Massachusetts 8. Carcases (or carcasses) of beavers, otters, martens, and other fur-bearing animals. 9. Amid a salvo of ordnance from the vessels in the anchorage. 10. The forest echoes with the guttural bellowings of the antlered monster and the plaintive answers of his consort. 11. They thought it advisable to leave the pinnace. 12. Where the gnu, the gazelle, and the hartebeest graze. 13. Dashing through the imminent deadly breach. 14. That wreathes its old fantastic roots so high. Indescribably, inaccessible, unnecessarily, beleagurers, demurred, merited, marvellous, perilous, ingenuous, ingenious, auxiliaries.

Name the prefixes, root and affixes, and meaning of each, of, "indestructibility. Value 10. Total 100.

CANADIAN HISTORY.

THE following is a continuation from last month of Questions and Answers on Canadian History :—

(1). What are the rival claims of England and France to Canada?

ANS.—Henry VII. of England, chagrined at the mistake which prevented his name being linked with that of Columbus, claimed the coast, and indefinitely inland, from Hudson's Bay to Florida, by right of the explorations of the Cabots, whom he sent out in 1497-8 ; but no attempt was made at settlement. Francis I. of France claimed the same territory by right of the explorations of Verazzani, who explored it and called it New France, 1524-5—by right of the explorations of the St. Lawrence by Cartier, 1534-5, and by subsequent settlement. England

laid no formal claim to the country till 1629, and even then in 1632 conceded France's better claim, reserving only the right to fish in Newfoundland waters. Considering that England virtually abandoned the country, or at all events neglected it, for 132 years after its discovery, while France was busy colonizing it, the latter's claim seems good in equity if not in law.

6. What is a *treaty*, and how did the treaties of 1713, 1748 and 1763 affect Canada?

ANS.—A small agreement between individuals is called a *bargain*; a larger, between individuals or companies, is called a *contract*, but a bargain between nations rises to the dignity of a *treaty*. A treaty is generally named after the place where it is signed, the year in which it was made, or some prominent person concerned in making it; thus, the treaty of 1713 is also known as the treaty of Utrecht, the treaty of 1748 as the treaty of Aix-la Chapelle, and the treaty of 1763 as the treaty of Paris. In 1689 war broke out between France and England, and the English and French colonies in America shared in the struggle. By the treaty or peace of Utrecht (1713) the claim by England to Acadie, (N. B. and N. S.) Newfoundland and Hudson Bay Territory, was acknowledged by France. Disputes between French and English Fur Traders brought on a war between the colonies; the French took some of the English territory and the English took some of the French; but by the peace of Aix-la-Chapelle (1748) both countries restored the respective portions which had been taken by them during the war. The old quarrels between the French and English Fur Traders shortly after broke out again, increased by disputes as to the dividing line between the several colonies. War ensued, and finally, in 1759, at the fall of Quebec, England had succeeded in becoming master of all the northern part of North America except three small islands South of Newfoundland, which France was allowed to retain for fishing purposes. At the Treaty of Paris, (signed Feb. 10, 1763) France gave up forever all claim to what is now Canada.

A LOVE SONG.

Golden-hued hair has my maiden most beautiful,
Lips like a rose-bud besprinkled with dew.
Cheeks like the blush of the clouds at the eventide,
Eyes of the color of heaven's own blue.

Light is her step as the moon o'er the mountain tops,
Sweet is her voice as the song of a dream,
Glad is her laugh as the ripple and cadence
And rythmical flow of a musical stream.

Vain is the pen of the poet to picture her;
Skilless the sculptor in marble to mould—
The art photographic the brush of the painter—
The work of the graver, though graven in gold.

These fashion figures that fade with the fashioner,
Dust dims the beauty which time will erase;
Love is the limner alone that can picture us,
Features eternity cannot efface.

Deep in my bosom a mystical canvas is
On it a face that is dearer to me
Than fame's adulations, the throne of a monarch.
The gold of the mountain, and gems of the sea.

Would you behold, my beloved, this paragon
Gaze on this queen of superlative grace?
Look in your mirror—behold in its sweetness
My heart-enshrined maiden's most beautiful face.

G. W. J——.

SCHOOL STATISTICS.

'Twas Saturday night, and the teacher sat
  Alone, her task pursuing;
She averaged this and she averaged that
  Of all her class were doing.
She reckoned percentage, so many boys,
  And so many girls all counted,
And marked all the tardy and absentees,
  And to what all the absence amounted.

Names and residence wrote in full,
  Over many columns and pages;
Canadian, Teutonic, African, Celt,
  And averaged all their ages,
The date of admission of every one,
  And cases of flagellation,
And prepared a list of the graduates
  For the coming examination.

Her weary head sank low on her book,
  And her weary heart still lower,
For some of her pupils had little brain,
  And she could not furnish more.
She slept, she dreamed; it seemed she died,
  And her spirit went to Hades,
And they met her there with a question fair,
  "State what the per cent of your grade is."

Ages had slowly rolled away,
  Leaving but partial traces,
And the teacher's spirit walked one day
  In the old familiar places.
A mound of fossilized school reports
  Attracted her observation,
As high as the State House dome, and as wide
  As Boston since annexation.

She came to the spot where they'd buried her bones
  And the ground was well built over,
But labourers digging threw out a skull
  Once planted beneath the clover.
A disciple of Galen wandering by,
  Paused to look at the diggers,
And plucking the skull up, looked through the eye,
And saw it was lined with figures.

"Just as I thought," said the young M. D.,
  "How easy it is to kill 'em,"
Statistics ossified every fold
  Of cerebrum and cerebellum;
"Its a great curiosity, sure," said Pat,
  "By the bones can you tell the creature?"
"Oh, nothing strange," said the doctor, "that
  Was a nineteenth century teacher."

CLIPPINGS.

The pupil must himself realize every rule which the master gives him. Action is the real teacher. Instruction does not prevent waste of time and mistakes; and the mistakes themselves are often the best teacher of all.

"Your handwriting is very bad indeed," said a gentleman to a friend more addicted to boating than to study: "you really ought to learn to write better." "Ay, ay," replied the young man, "it is all very well for you to tell me that; but if I were to write better, people would find out how I spell."

A shrewd Wisconsin teacher had "a general information class" last year, whose exercises consisted merely of half-an-hour's reading and discussion of the daily newspaper. It is said that the plan worked admirably. The pupils were kept well informed in current affairs, and showed a greater proficiency in ordinary studies after the class was organized. This is worth trying in all schools where there is time for it.

Here is a new receipt for making a blackboard mixture which is said to work well and costs but little: Extract of logwood one-half pound, dissolved in five gallons of hot water; and ½ oz. bichromate of potash; strain and bottle. Of this consistency, it is adapted for writing fluid. Less water should be used for blackboards. Apply with cloth to smooth, white wood.