The German, Netherlands, and Belgian Pharmacopœias define quantities less than 1 mg. as unweighable, the Swiss and Danish Pharmacopœias quantities of 0.5 mg. and less. Crucibles or dishes of platinum are usually preferable to porcelain for exact determinations of non-volatile and non-combustible matter, on account of better heat conduction and because of reaction of some ash constituents with silicates at high temperatures, with a consequent loss in weight of the residues. For quantities of 0.1 to 0.2 gm., platinum crucible lids are generally best suited. The German Pharmacopœia give the following directions for ash determinations: A suitable quantity is first carbonized in a crucible at a low temperature, then incinerated. To hasten combustion of the carbon, the flame is removed from the crucible occasionally for a short time. If complete incineration cannot be attained by a moderate heat, the mass is mixed with hot water and transferred to a filter of known ash content. The filter and contents are washed with a little water, then returned to the crucible, dried and incinerated. After cooling, the filtrate and washings are added and evaporated on a water-bath after addition of a little ammonium carbonate. The residue is heated to dull redness, cooled, weighed, and filter ash subtracted.

(To be continued.)

STATE BOARD OF PHARMACY QUESTIONS ON CHEMISTRY.

A. H. CLARK.

At the joint session of the Section on Education and Legislation with the Boards of Pharmacy, and Pharmaceutical Faculties, held during the Boston meeting and reported in the Bulletin of the American Pharmaceutical Association for December, 1911, there was presented the report of the Committee on Examination Questions. This committe was appointed by the Chairman of the Section in accord with a resolution passed during the Richmond meeting (1910).

I take it that the sole object of this work is to bring about a discussion of the subjects which are of mutual interest to the Boards of Pharmacy, Pharmaceutical Faculties, and to the candidate before these Boards and Faculties, as well as to the pharmacist in general. Free discussion and liberal criticism are the best means of furthering this end, and as I had not the pleasure of attending this particular session, I am taking the liberty of presenting here a few remarks on the questions submitted as proper for candidates writing on chemistry.

Examining bodies such as Boards of Pharmacy, must bear in mind that the candidate who appears before them may have secured his knowledge of chemistry from any of the following sources: He may be a university graduate, he may be a graduate from a college or school of pharmacy, he may have obtained his knowledge from some correspondence course, he may have obtained it from some night school, or from some "quiz course," or from a private tutor, or from his employer, or by individual effort alone. These conditions are made possible by the variation in requirements exacted by the different State Pharmacy Laws. For this reason no one set of questions can be prepared to fit every case, and each

Board of Pharmacy must frame its questions to fit the conditions prevailing in its particular territory.

There are, however, certain fundamental principles which should govern every examiner in preparing his questions, and the most important of these are enumerated in the report of this committee. (Bull. Am. Pharm. Assn., Vol. VI, No. 12, p. 661, Dec., 1911.)

Questions should be so worded that there can be no possible misunderstanding *(in the mind of the candidate)* as to their import.

Catch questions, as well as those relating to obsolete subjects, should be avoided.

Due consideration should be given to the candidate's source of information, as well as the date at which he obtained it. This is of vital importance. There are many questions in chemistry on which the highest authorities differ decidedly. An examination of a number of text books on a stated subject will bring to light a number of different views, and on some questions, widely different. Every teacher of chemistry will impart to his students his own peculiar ideas on disputed subjects and the successful examiner is the one who selects his questions and so frames them that they will admit of but one correct answer no matter what the residence or training of the candidate may have been. I have seen many questions on chemistry asked in State Board Examinations which, because of their ambiguity, I am certain I could correctly answer and yet fail to receive a single credit mark.

The examiner should bear in mind that he is not instructing in the subjects on which he examines the candidate and therefore his (the examiner's) particular views must not constitute the standard by which the candidate is judged. Men of the highest attainments and ideals and wide experience disagree on many subjects, and the examiner must admit this and give the candidate full credit for answers made in accord with the views of any recognized authority, or better still, strive to avoid touching on subjects which cover disputed ground.

Above all, questions should be so framed that the candidate can not answer them by a simple "yes" or "no" alone, or by a set definition. This requirement while important is one difficult to meet, I know. Students will learn definitions, and we are obliged to admit that this is better than nothing, although one may write definitions without end and never display any real knowledge of the subjects discussed.

I know that students generally think that if they can write an equation they know all that is necessary and many candidates before State Boards have the same idea. As a matter of fact an equation usually tells very few of the facts in the case. I would make it plain in every instance whether or not equations are desired. If an equation is wanted and nothing more, I would ask the candidate to write an equation to show this or that reaction. If equations are not wanted I would make it plain by asking the candidate to tell, without the use of equations, what happens when this and that react.

The candidate should not be expected to memorize figures such as atomic weights, specific gravity, boiling points, melting points, etc.

Let us see to what extent the questions submitted meet these requirements.

1. What are acids? Give the chief chemical properties of acids.
2. What are bases? Give their chief chemical properties.
3. What are salts?

The first part of these questions calls for an out and out definition. Suppose the candidate said that "There is but one acid, and that is hydrion." What credit would the examiner give him? And yet, "in terms of the ionic hypothesis, there is only one acid, hydrion (H')" is quoted from Smith, General Inorganic Chemistry, 1st Edition, p. 345.

Ostwald, Principles of Inorganic Chemistry, Findlay's Translation, 3d Edition, p. 188, et seq., refrains from giving a definition. He says: "In the name acid is summed up a whole series of properties." "All acids contain hydrogen which they evolve under the action of magnesium." He sums up the discussion of salts by saying that "salts are electrolytes." What would be the fate of the candidate who wrote as an answer to question three, "Salts are electrolytes"?

Noyes, Organic Chemistry, 1903, p. 221: "With our present conception of acids it seems to be a little difficult to frame a definition of organic acids or, indeed, of acids in general, which is not more or less arbitrary."

McPherson and Henderson, Elementary Study of Chemistry, Revised Edition, p 107: "An acid is a substance which produces hydrogen ions when dissolved in water or other dissociating liquids." Here we find a definition.

Kahlenberg, Outline of Chemistry, 1911, p. 121: "An acid is a compound containing hydrogen which may be replaced by a metal, the product formed being a salt."

Dagget, Theory of Pharmaceutical Chemistry, p. 110: "When hydrogen is the base, an acid is formed, commonly having a sour taste," etc.

Attfield, General, Medical, and Pharmaceutical Chemistry, 16th Edition, p. 267: "Hydrogen salts (hydrogen easily replaced, wholly, or, in certain cases in part, by ordinary metals) are the common, sharp, sour bodies termed acids."

Sadtler and Coblentz, A Text Book of Chemistry, 4th Edition, p. 133: "Acids are compounds of hydrogen with an electro-negative element or radicle."

Here we have the ideas of a number of authors and some confusion is noted. Whether acids are the real salts of hydrogen or whether acids are the liquids resulting from a solution of these salts in water is, according to our modern theories, an open question. The U. S. P., VIII, defines hydrochloric acid as "a liquid composed of 31.9 per cent. of absolute Hydrochloric Acid ($HCl = 36.18$)." Evidently this authority considers the gaseous hydrogen chloride an acid as well as its solution in water. Nearly all authorities agree that hydrogen chloride has very few if any "acid properties."

I have considered this question in detail as typical. When such differences of opinion are noted upon a subject so generally dealt with, and of such great importance, what can we expect on subjects of relatively slight importance and upon which no such amount of thought and experiment has been expended?

I fully appreciate the thought in the mind of the examiner when he framed these questions, but I think the object desired could best be accomplished in an entirely different manner. I would ask the candidate in place of question one, to mention the chief chemical properties of hydrochloric acid U. S. P. Objection might be made to this. The candidate might say that when hydrochloric acid is mixed with a solution of silver nitrate a white curdy precipitate is formed, etc. If he does, it is so much the better, as it shows he knows something about the properties of chlorides, and this is but one of the many prominent properties of

hydrochloric acid. If he mentions all the prominent properties, he must mention those that are peculiar to acids in general. If the candidate has a good general knowledge of acids he certainly can answer this question with little trouble. In the same way I would ask him in place of question two, to mention the chief chemical properties of a solution of sodium hydroxide in water.

As to question three a candidate will be more confused than by the first or the second question. Some writers would include "acids" (HCl, H_2SO_4, etc.) as salts. Are such compounds as FeS, Fe_2O_3, CaO, etc., salts?

The three questions might be combined to excellent advantage, and I would do so by asking the candidate to mention the chief differences in chemical properties of hydrochloric acid U. S. P., a solution of sodium hydroxide in water, and a solution of sodium chloride in water. The candidate who knows anything about "acids," "bases," and "salts," would necessarily have to display this knowledge to answer such a question.

4. Define the difference between normal, acid, and basic salts.

This is typical of many. Does this mean difference in color, in taste, in odor, in composition or constitution, or in therapeutic action? A candidate might know that usually normal bismuth nitrate is crystalline and the basic salt is a powder. That is a difference in these salts. I would ask him to explain, without the use of formulas, the difference in constitution (composition or chemical composition) betwen normal bismuth nitrate and basic bismuth nitrate. Or explain, without the use of formulas, the difference in constitution between sodium sulphate and acid sodium sulphate.

5. What is the official strength and specific gravity of sulphuric acid? What is meant by 66° acid?

This is not a chemistry question. It is a memory test. Further, is the U. S. P. acid indicated or the usual commercial acid? I would never require statements of this kind. There are a few instances where the strength of pharmaceutical preparations should be known, preparations containing dangerous or poisonous drugs, but never such data as is called for here. "66° acid" is obsolete in pharmaceutical practice, I think.

6. How is hydrochloric acid made? Give strength and specify gravity.

First of all, does the question call for a method of manufacturing HCl, or hydrochloric acid U. S. P., or of an acid of commercial quality? In any case it may be made by more than one method. I would ask the candidate to state how hydrogen chloride may be made from salt and sulphuric acid. Or if this seems to give too much information, ask him to tell how it might be made from salt. Or ask him how hydrochloric acid might be prepared from salt. I would not ask for strength or specific gravity.

7. What is meant by water of crystallization?

This is all right but does not bring out a candidate's knowledge of chemistry to any extent.

8. What percentage of dry sodium carbonate does $Na_2CO_3+10\,H_2O$ contain?

When questions involving atomic weights are asked I would give the candidate the necessary data.

9. How would you distinguish between ferrous and ferric salts?

This question might be a little more explicit. One might distinguish between

ferrous chloride and ferric sulphate by the fact that the former, dissolved in water and mixed with a solution of silver nitrate precipitates silver chloride and the latter does not. I would ask the candidate to distinguish between ferrous chloride and ferric chloride. He must know the tests for the two iron ions to answer this question.

10. Enumerate the chief differences between mercurous and mercuric salts.

The same criticism applies here as mentioned under questions four and nine. Many would say in this particular instance that mercurous salts are not poisonous, mercuric salts are, having in mind calomel and corrosive sublimate. This is one decided difference.

11. Give official name of mercuric iodide and describe it. State how it is made.

This question does not bring out a candidate's knowledge of chemistry to any great extent. It is more of a pharmacy question.

12. How is chlorine made?

Chlorine is made in a number of ways. Must the candidate describe all of them? Or only one? I would ask him to describe two ways by which chlorine is made, or may be prepared. Or to describe the manufacture of chlorine from manganese dioxide, or how it may be prepared by the electrolysis of sodium chloride.

13. Show by chemical equation how chlorine is liberated from bleaching powder. What percentage of chlorine should bleaching powder contain? Explain how chlorine acts as a bleaching agent.

Authorities differ as to the composition of bleaching powder. The U. S. P. does not state its composition. Ostwald says the question is not settled. This is a complicated subject at best. I would select as a test of the candidate's ability to write equations some interaction that is better understood and less complicated. The second part of the question is not clear. I am sure that the per cent. of chlorine contained in bleaching powder is not what is wanted, but the per cent. liberated on decomposition by acids, or the available chlorine is desired. It should not be required that a candidate remember this figure.

14. Complete the following equations:

$$Zn + H_2SO_4 = ?$$
$$MnO_2 + HCl = ?$$

This is the most ambiguous question in the list. It is an indisputable fact that every reaction takes place under stated conditions. As the conditions of temperature and concentration vary, the nature of the products produced in any chemical change will vary. Zn and H_2SO_4 do not interact at all, under ordinary conditions. If the H_2SO_4 has mixed with it a little water, say 5 per cent., there is still little or no action on the zinc at ordinary temperature. If the mixture is heated, zinc sulphate is formed with the evolution of sulphur dioxide and water. If the H_2SO_4 is mixed with a large amount of water, reaction takes place under ordinary conditions with the formation of zinc sulphate and hydrogen. Which one of these reactions does the examiner have in mind, and how is the candidate to read the examiner's mind? I would ask the candidate to write an equation to show the action of diluted sulphuric acid U. S. P. on zinc. Or to write an equation showing what takes place when zinc and concentrated sulphuric acid are mixed and heated. Even more indefinite than this is the question along similar lines that I have seen

in some lists of State Board questions. "Complete the following equation: $Zn + HNO_3 = ?$" Any one of a dozen or more things happen, depending on the conditions of the experiment.

17. What is a hydrocarbon? Give official name and describe an official hydrocarbon.

The question leaves a doubt as to what is meant. Explain the constitution of, or the composition of, or what are the elementary constituents of the hydrocarbons, seems to me to be better. "Give official name." There is two distinct meanings to the term "official name" when applied to organic compounds. The name given to the compound by the U. S. P. is one, and the name given to it by the Congress of Chemists, held at Geneva in 1892, is another. This latter to the chemist is the only "official name." There are several official hydrocarbons. If this is worded in this way intentionally, to allow the candidate a choice, I see no objection, except that the word "describe" is not well chosen. Is it intended that the candidate shall describe its physical properties, or explain its chemical constitution and properties? I would ask the candidate to explain the chemical constitution of benzin, or petrolatum U. S. P., or to state the most prominent chemical properties of benzin, or petrolatum U. S. P.

15. How much zinc is required to make 100 grms. $ZnSO_4$.

(Atomic weight $Zn = 65$, $H = 1$, $S = 32$, $O = 16$.)

All right as a problem except the candidate is asked to tell how much. Does this mean how many pounds, or cubic inches, or grains, or what? I would ask the candidate to state what weight is required.

16. 5 cc. of sodium hydroxide solution require 47 cc. normal H_2SO_4 to neutralize it, what is its percentage strength?

Must the candidate remember the molecular weight of sodium hydroxide? He certainly should not be required to do so. He is also asked to calculate the percentage strength of a solution by calculating the weight in a given volume. This is an impossibility. The weight of sodium hydroxide in 100 cc. of the solution should be asked for.

18. Give the chemical formula, strength, and specific gravity of official alcohol. State briefly how it is made.

Strength and specific gravity are again asked for. Not a question in chemistry but a memory test.

Some one might memorize the formula C_2H_6O and know nothing at all about the subject. I would ask the candidate to represent the composition of alcohol by a structural formula.

Alcohol may be made in several different ways. The candidate is entitled to know exactly what is wanted. I would ask him to state how alcohol is made by the fermentation of grain, if that is what is wanted. I am informed that it is being produced on a commercial basis from sawdust. It may be made by a number of purely chemical processes.

19. What is wood alcohol? How can it be detected in ordinary alcohol? The same remarks apply here as made under seventeen. Explain the constitution, or chemical composition, I think is better.

20. What is denatured alcohol?

There are numerous denatured alcohols. If some one happened to know the

composition of one and wrote it he has answered the question. I would ask the candidate to explain what is meant by denaturing alcohol. This question does not bring out a candidate's knowledge of organic chemistry to any extent and I would refrain from touching upon it at all.

21. What is chloroform U. S. P. and how is it made commercially?

Is the constitution wanted, a description of its physical characteristics, or its chemical properties, or would the U. S. P. definition answer? I would indicate exactly what is wanted.

I believe that very few know how chloroform is made commercially. They may know from what it is made but not how. It is made in one way, and I would indicate the exact method, if I asked the question at all.

22. Give specific gravity and solubilities.

Of what? I would suspect that the question refers to chloroform but I may be entirely wrong. It is not a chemistry question in any way.

23. Describe two methods of making acetic acid.

Is it desired that the candidate describe the so-called "slow vinegar process" and the "quick vinegar process"? Suppose the candidate described its manufacture by the action of potassium dichromate upon alcohol, or by the destructive distillation of wood, or any of the several other methods he might mention, has he answered the question? If the two fermentation processes are what is wanted I would make it plain by asking the candidate to describe the two fermentation processes in common use. The question in this sense is not a good chemistry question.

24. Give a general description of acetates.

Chemical or physical characteristics or both? I would ask the candidate to mention the most prominent chemical characteristics of acetates or to discuss the chemical properties of acetates.

25. Distinguish between benzin and benzene both physically and chemically.

There is no serious objection to this question. To well describe the difference in physical properties would involve memorizing the physical constants of the two, which should not be required.

I do not know whether this list is intended as an example of questions for candidates writing for an assistant's certificate or for a full registered certificate, using the terms in the sense that they are applied in Illinois. Possibly it is intended to cover both. At any rate, no matter what is intended, I see no questions on those very important elements iodine and bromine. There is not a single question relating to the compounds of sulphur (except number five), phosphorus, arsenic, antimony, the alkali metals, or nitrogen, all of which are of the utmost importance to the pharmacist. Very little to bring out the candidate's knowledge of the nomenclature of salts. Very little that would test his knowledge of the analytical reactions of the metals, of the more common identity and purity tests of the U. S. P. I realize that it would be impossible to include everything in one set of questions, but I would omit such questions as those relating to solubilities, specific gravity, methods of manufacture, questions like numbers seven and eleven, and even the problems, and include some on these very important subjects.