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Chemistry and Physics in Accounting

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Among the compulsory requirements of the preliminary educational tests for applicants for examination for the C. P. A. degree in New York are some two out of these three subjects: chemistry, biology, physics. Not a little resentment is felt by accountants who, not having had college courses, are called upon to pass examination on these subjects, which they consider purely academic studies, divorced from the work of public accountants. How far cultural qualifications should be imposed as a condition to the granting of a degree is a question that I do not wish to discuss, although, frankly, I have much sympathy with the low-brow view.

Is it a fact, however, that knowledge of chemistry and physics is not of much practical value to the accountant? In rather a long experience as public accountant a knowledge of chemistry has served me to far more purpose than algebra. Some illustrative cases may be mentioned. An examination of the inventory of a corporation producing copper, nickel, cobalt, gold and silver was in progress. Among the items listed at the works in Canada was a large quantity of a copper by-product concentrate, listed as "copper oxide, 82 per cent." It had been valued as containing 82 per cent. of copper. As copper oxide is CuO_2 it can contain only 66 per cent. of copper. The auditor questioned the valuation and on reference to the works it was found that the material contained 82 per cent. of copper oxide, or 54 per cent. of copper, changing the value widely.

An investigation of certain chemical plants showed Corporation A producing cyanide and Corporation B, partly owned, producing sodium metal and having, of course, chlorine as another product. Leaving aside other complications, Corporation A depended on B for its sodium, and while it owned a large share of B there were others interested in B who wanted all the profit they could get. Now, the price of transfer of sodium metal could not be arranged on the basis of a free market for there was none for such quantities, nor could such quantities be freely bought at all. The auditor was called upon to make a certified statement of the earnings of A in view of possible change of ownership. What would have been his position if he had not known enough to realize and express clearly the limitations on the earning power due to dependence on an arbitrary price adjustment with B?

American iron and steel producers use iron ore containing as little as 50 per cent. iron; there is in Brazil—provinces of Minas Geraes and Goyaz—certain hard hematite ore containing up to 68 per cent. iron; and in Great Britain ores are smelted containing less than 35 per cent. iron. All figures are after drying. Leaving out of consideration the impurities sulphur and phosphorus, the non-chemical accountant, knowing that impurities must be got rid of as slag, would be likely to figure

Brazilian ore	68% useful	32% to slag
American "	50% "	50% "
British "	35% "	65%

But these figures are simply silly. As the iron is present as Fe_2O_3 the true comparison is

	(Fe_2) metal	(O_3) given off as gas	(Gangue) to slag
Brazilian ore	68	29.2	2.8
American "	50	21.4	28.6
British "	35	15	50

(Some American ores—Vermillion Range—contain over 60%)

It becomes evident that in the first case there will be no appreciable slag except that derived from the fuel; that the amount of lime and of fuel will be greatly reduced; and that the relative values of the ores bear little relation to the simple figures of iron content. Many British works produce two tons of slag to one ton of iron. If, on the other hand, the metal were gold the percentage of content would be nearly indicative of value, since the cost of extraction would be almost negligible.

The above are extreme cases; but consider the relative values of ores containing respectively 45 per cent. and 55 per cent. iron when dried. In the first case the matter entering into the slag is 35.7 per cent.; in the second case 21.4 per cent. In the first case for each ton of contained iron there will be 8/10 ton of matter to be absorbed in slag, and in the second case less than 4/10 ton of such matter per ton of iron. These figures are widely different from the figures that would be derived by an accountant having no knowledge of chemistry and show why apparently minor differences in ores may cause great difference in values. In comparing values put on ore deposits in cases of consolidations of blast-furnace enterprises, mental distress awaits the accountant who cannot prove to his own satisfaction points of this kind. For simplicity it has been assumed that the impurities are all alike so that only quantity counts.

The accounts of a brewery showed high cost of materials. (This was before we submitted our bill of fare to Mr. Volstead.) The owner explained that it was very good beer. It was. But the auditor, having the analysis, could not account for all the malt used, and on showing his figures to the brewmaster found, to the surprise of the owner, that false yeast had made its appearance, and many brewings had been run quietly into the sewer.

But the most common need for some chemical knowledge is in cost accounting. C. Wadsworth, one of the editors of *Chemical & Metallurgical Engineering,* in a recent issue of that magazine pointed out the absurdities committed by cost accountants in dealing with industries in which chemical and metallurgical operations are carried on. He puts the case of a cost accountant who, figuring on the output of a manufacturer of salt cake—sulphate of soda—reported a profit on sulphate of soda and a loss on hydrochloric acid, recommending increase of effort to push the sale of the one and the abandonment of the other. An elementary knowledge of chemistry might have saved the accountant but he did not have it. The process is the treatment of salt—sodium chloride—with sulphuric acid, the products being sodium sulphate and hydrochloric acid; thus:

Sulphuric acid		Salt		Sodium sulphate		Hydrochloric acid gas
H_2SO_4	+	$2NaCl$	=	Na_2SO_4	+	$2HCl$
Weight 98		117		142		73

The accompanying water is omitted from the statement of the reaction as it takes no part in it. It is clear that for every 142 pounds of anhydrous salt cake you must make 73 pounds of dry hydrochloric acid gas whether you want to do so or not; and not only was the suggestion to push the sale of salt cake without trying to make and sell the hydrochloric acid a foolishness, but the cost accounts themselves, showing a profit on one and a loss on the other of two joint products, were necessarily all wrong in principle.

It is ignorance of this kind that brings to cost accountants and auditors enmity of manufacturers generally, and the case is by no means helped by the positive attitude so often found among cost accountants.

As to physics, a similar condition exists. As an instance of the need for a knowledge of physics the case of the gas department of the Public Service Corporation of New Jersey may be cited. That company makes much of its gas at Camden, distributing it at varying pressure, often 25 pounds to the square inch or more, to towns in the central and northern parts of the state, the gas passing through pressure regulators which bring down the pressure to a few inches of water before it passes through the consumer's meter. To agree the volumes of gas manufactured and distributed, taking into consideration changes in pressure and temperature, and to compute therefrom, even very roughly, the amount lost by leakage or by theft is not possible without some knowledge of the laws governing the change of volume of gasses under change of pressure and temperature.

It is not necessary nor even possible that accountants should have such a thorough knowledge of these subjects as is needed by professional chemists. They need not be able to say how much the value of iron ore is affected by the fact that it contains too much phosphorus for Bessemer pig and too little for basic open-hearth work; but they should be able to understand when explanations are given to them and to judge of the reasonableness of the explanations.

The foregoing is intended to show the wide use to which some knowledge of chemistry and physics may be put by the accountant. It is natural to ask, Where shall he stop? In an acetic-acid factory a bowing acquaintance with penicillium glaucum might be useful; in a camera-manufacturing plant a knowledge of the extreme limit of light rays on the violet side that can pass through lens thicknesses of borate glasses; in a shipyard the meaning of metacentric height. Indeed, there is no knowledge that may not be of some use to an accountant. How much knowledge, then, is he chargeable with that he may be rated a competent professional? He can't know it all and must not begin to think he does.

A general knowledge of chemistry and physics is now part of the equipment demanded of every intelligent professional man; and even if it were not so their universal application to manufacturing cost accounts would make it worth the while of any professional accountant to learn something of them. It is probable that if any public accountant, for the lack of an elementary knowledge of chemistry or physics, should pass and certify accounts where such a knowledge would have demonstrated their falsity or have shown them to be grossly misleading, he would be subject to severe blame.

Accountants cannot hide behind the defense that they are ignorant of all but figures; they must be equipped to apply a reasonable amount of check to everything that affects the accounts they certify. Nothing outside of strict accounting seems to be more useful for the purpose than some knowledge of chemistry and physics. Among the accounting items that are always better dealt with in the light of such knowledge are depreciation, obsolescence, manufacturing costs, discrimination between capital additions and expenses, inventories and the valuations applied to natural resources. These are not trifles, and the errors possible through ignorance of chemistry far overshadow those differences as to which we hear great argument among accountants relative to scientific amortization, etc.

Finally, it cannot be made too clear and emphatic that the accountant should not criticise nor pose as an authority on the chemistry or physics of operations on which he reports. His use of any knowledge he may have of these subjects is to be confined strictly to assisting him in understanding and examining accounts and to protecting himself from certifying faulty accounts. The combination appraiser, general "industrial engineer" and accountant is perhaps the most offensive charlatan on the market and is tolerated mostly because so many accountants lack a little general technical knowledge to guide them in their strictly accounting duties. Most manufacturing involves chemical operations; all, without exception, involve questions of physics. We report on these operations and even prescribe rules and forms for recording them. Shall we say we do not need any knowledge of chemistry or physics?