mined by a specific gravity test, weighting the ice with platinum,and using mercury as a means of making the test, that substance remaining fluid at low temperatures, and having no solvent power on ice. It would be easy to make a proper allowance for the increased specific gravity of the mercury as the temperature diminishes.

TRANSPORTATION OF CATTLE---REID'S PATENT CATTLE WAGONS.

Some years since, while we were standing in the depot of the New York Central Railroad, at Amsterdam, awaiting the arrival of an express train from the East, there passed the station two enormous trains from the West, each requiring two locomotives to draw them, and laden with live cattle for the New York market. Live cattle, did we say? We must qualify that statement, for, on either train, there were some dead,others in a dying state,while all were greatly distressed, as was evident by their violent panting and protruding tongues. Some were prostrate under the feet of the rest, powerless to rise. The causes for this state of things was obvious. The weather was intensely hot, and the cattle crowded together as close as they could possibly stand, and not having been allowed to drink since they left Buffalo,were dying of thirst. We remarked, at the time, that it seemed an easy task to provide water for cattle thus transported, but a fellow traveler remarked that, were a proper apparatus constructed, no railroad in this country would adopt it unless compelled to do it. We, however, hoped, and still hope, that the greed of railroad corporations will not prevent the universal adoption of any simple method for securing such a humane object.

Our attention has been called to a simple and effective mode of supplying cattle with water while being transported in railway cars, invented by Wm. Reid, of Granton Harbor, near Edinburgh, Scotland, which seems admirably adapted to the purpose. The cars are provided with troughs, to which water can be readily supplied while the trains are stopped for taking in water for the use of the engine.

There is no doubt that many cattle become diseased by confinement without water during transportation, and that their meat, rendered more or less unwholesome by it, is sold and eaten, to the detriment of public health. The knowledge of this fact will do more toward correcting the evil than an appeal to the humanity of individuals. If railroad corporations refuse to correct it, they should be compelled to do so by legislation.

NEW MEXICO, ITS NATURAL WEALTH.

The Honorable W. F. M. Arny, ex-governor of New Mexico, has presented to the geological and mineral museum of the United States Department of Agriculture, a collection of specimens of minerals, fossils, agricultural products, etc., from which an idea of the natural resources of that territory may be obtained.

Among these specimens are native copper from the Tijeris mountain, a short distance from Santa Fe; bituminous shale from Placer mountain; iron ore from the San Juan country; brown copper ore from the San Dio range, also but a short distance from Santa Fe; limonite from the vicinity of Placer mountain; purple copper and native copper from the Naciamento mountains; iron pyrites, drusic, quartz, felspathic trachyte, pumice, and trachyte from the San Juan. Indian country; argentiferous galena from Stevenson's mine in Dona Anna county, native copper from Hanover mine near Gila river; marble from near Santa Fe; argentiferous galena from Valencia county; dentritic manganese in felspar paste containing gold, from Placer mountain; gold bearing quartz and native copper from the vicinity of Abiqui, Rio Arriba county; conglomerate containing gold from the Ute creek on Maxwell's ranch stated to be unsurpassed in richness, various grades of wool, corals, and so forth.

Striking as is this exhibit of mineral wealth, there is little doubt that much remains yet to be discovered. The rapid development of these resources is however interfered with by the depredations of Indians who render mining operations, except in places near centres of white population, extremely hazardous. Governor Arny asserts his belief that the mineral wealth of the mountains of New Mexico would pay twice our national debt, if miners could be permitted to develop it in safety. His opinion is that "is is cheaper to feed than to fight Indians, and that the Indians of New Mexico can all be placed on reservations without a war, if Congress will make sufficient appropriations to feed them, and furnish the necessary machinery to enable them to make their own clothing and establish industrial schools, to be kept up at the expense of the Government till the Indians are made self sustaining, which, by faithful agents, can be done in a few years."

With these Indians such a plan might prove successful, as they are said to be already partially civilized, but so far as our knowledge of Indian reservations extends they are generally constant bills of expense to the Government; the Indians are not self-sustaining and the agents are far more interested in making money for themselves, than in caring for the trusts imposed upon them. We have always held the opinion that a race who will not become civilized, and who at the same time resist the onward sweep of civilization, must not only be inevitably swept before it to extinction, but that they deserve scarcely more sympathy than the other savage beasts of the forest whose ferocity they not only imitate, but surpass. We believe that although feeding may be cheaper—so far as money goes—than fighting, the only effectual remedy for Indian outrages on our frontiers, is the strong hand. The only way to conquer the American savage is to punish such outrages by almost total extermination of the tribes that perpetrate them. To exhibit mercy to these butchers is to waste powder.

ON A PROBABLE CONNECTION BETWEEN THE RESISTANCE OF SHIPS AND THEIR MEAN DEPTH OF IMMERSION.

By W. J. MACQUORN RANKINE, C.E., LL D., F.R.S.

1. It was pointed out some time ago, that when a wave in water is raised by a floating solid body which is propelled at a speed greater than the natural speed of the wave, the ridge of the wave assumes an oblique position, and the wave advances obliquely; so that while it travels at its own natural speed in a direction perpendicular to its ridge line, it at the same time accompanies the motion of the solid body at a greater speed. The angle of obliquity of the advance of the wave is such that its cosine is the ratio of the natural speed of the wave to the speed of the solid body. It was at the same time pointed out that under those circumstances there is an additional breadth of wave raised in each second, expressed by the product of the speed of the solid body into the sine of the obliquity; or, in other words, by the third side of a right-angled triangle, of which the speed of the solid body is the hypothenuse, and the natural speed of the wave the base; that in raising that additional breadth of wave per second, energy is expended; and thus that a rapidly increasing additional term is introduced into the resistance to the motion of the solid body, so soon as its speed exceeds the natural speed of the waves which it raises.

2. The waves taken into account in Mr. Scott Russell's theory of the resistance of ships, are waves whose speed depends on their length alone; and that theory accounts for a rapid increase in the resistance of a ship, when her speed exceeds the natural speed of certain waves of lengths depending on her length.

3. In a paper read to the Royal Society in May, 1868, it was shown that for all waves whatsoever, there is a relation between the natural speed and the virtual depth of uniform disturbance, that is to say, the surface particles would have to extend in order to make a total volume of disturbance of the water equal to the actual volume of disturbance. That relation is, that the speed of advance of the wave is that due to a fall of half the virtual depth. In a paper read to the Institution of Naval Architects in 1868, it was pointed out that every ship is probably accompanied by waves, whose natural speed depends on the virtual depth to which she disturbs the water, and that, consequently, when the speed of the ship exceeds that natural speed, there is probably an additional term in the resistance depending on such excess.

4. The object of the present paper is to call the attention of the British Association, and especially of the committee on Steamship Performance, to the probable existence of this hitherto neglected element in the resistance of ships; and to suggest that suitable observations and calculations should be made in order to discover its amount and its laws. Among observations which would be serviceable for that purpose may be mentioned the measurement of the angles of divergence of the wave ridges raised by various vessels at given speeds, and the determination of the figures of those ridges which are well known to be curved; and among results of calculation the mean depth of immersion, as found by dividing the volume of displacement by the area of the plane of flotation; and that not only for the whole ship, but for her fore and after bodies separately, for it is probable that the virtual depth of uniform disturbance, if not equal to the mean depth of immersion, is connected with it by some definite relation.

Results of Observations.—In an appendix are given the results of the only three observations which I have hitherto found it practicable to make, of the speed of advance of the obliquely diverging waves raised by ships. The waves in each case were those which follow the stern of the vessel; the vessels were all paddle steamers, but care was taken to observe the positions of the wave ridges where they were beyond the influence of the paddle race. The virtual depth corresponding to the speed of advance of those waves is calculated in each case, and it is found to agree very nearly with the mean depth of immersion. It is to be observed, however, that the mean depth of immersion of one vessel only, viz., the *Iona*, has been measured from her plans. For each of the other vessels, a probable value of the mean depth of immersion has been obtained, by assuming that it bears the same proportion nearly to the total draft of water in them as in the *Iona*. That assumption cannot be very far from the truth, for the three vessels belong to the same class of forms, being of shallow draft, and very flat bottomed amidships, but having very fine sharp ends. Few as those observations are, they seem sufficient to prove the existence of waves whose speed of advance depends on the depth to which the vessel disturbs the water. The connection between those waves and the resistance remains as a subject for future investigation.

Glasgow University, 15th August, 1868.

APPENDIX.

1. *Steam Vessel "Iona."*—Speed of vessel at time of observation, 15 knots=25·35 ft. per sec.; angle made by ridges of stern waves with course of vessel, $22\frac{1}{2}$°; sine of that angle, 0·383; product, being velocity of advance of stern waves, 9·71 ft. per sec.; virtual depth corresponding to that velocity $9{\cdot}71^2 \div 32{\cdot}2 = 2{\cdot}93$ ft.; mean depth of immersion of vessel as measured on her plans, 3 18 ft. N B.—The draft of water was 5 ft., so the mean depth of immersion was 0·64 of the draft, nearly.

2. *Granton and Burntisland Ferry Steamer.*—Speed of vessel at time of observation, 10 knots=16·9 ft. per sec; angle made by ridges of stern waves with course of vessel, 45°; sine of that angle, 0·7071; product, being velocity of advance of the stern waves, 11 95 ft. per sec.; virtual depth corresponding to that velocity, $11{\cdot}95^2 \div 32{\cdot}2 = 4{\cdot}44$ ft.; draft of water of the vessel, 6·67 ft; probable mean depth of immersion on the supposition that it is 0·64 of the draft, 4·3 ft.

3. *Steam Vessel "Chancellor."*—Speed of vessel at time of observation, 12·64 knots=21·36 ft. per sec.; angle made by ridges of stern waves with course of vessel, 22°; sine of that angle, 0·375; product, being velocity of advance of the stern waves, 8 01 ft. per sec.; virtual depth corresponding to that velocity, $8{\cdot}01^2 \div 32{\cdot}2 = 2$ ft.; draft of water of the vessel, 3·5 ft.; probable mean depth of immersion, on the supposition that it is 0·64 of the draft, 2 24 ft.

TABLE OF VIRTUAL DEPTHS CORRESPONDING TO DIFFERENT VELOCITIES OF ADVANCE.

Velocity of advance.			Virtual depth.	
Knots.	Feet per second.	Meters per second.	Feet.	Meters.
1	1·69	0·515	0·09	0·27
2	3·38	1·03	0 35	0·08
3	5·06	1·54	0·80	0·243
4	6 75	2 06	1·41	0 433
5	8·44	2·57	2 21	0676
6	10·13	3·09	3·18	0·973
7	11·8	3·60	4·33	1·325
8	13·5	4 12	5·66	1 73
9	15·2	4·63	7·16	2·19
10	16·9	5·15	8·84	2·70
11	18 6	5 66	10·7	3·27
12	20 3	6 18	12·7	3·89
13	21·9	6·69	14·9	4 57
14	23·6	7·20	17 3	5·30
15	25 3	7·72	19·9	6 08
16	27·0	8·24	2 ·6	6·92
17	28 7	8 75	25 6	7·81

—*The London Artizan.*

CHEMICAL NOMENCLATURE.

[Continued from page 50.]

The combination of the different elementary substances takes place by a certain attractive power of their smaller particles (atoms or molecules), which is called chemical affinity. As may be expected *a priori*, it differs greatly in different substances, and even differs in the same two substances when the circumstances are changed. The principal modifying circumstance is heat.

Carbon and oxygen, at the common temperature, have no affinity, that is to say, they will not combine. A piece of carbon may lie for a century in oxygen gas without combination taking place, but when sufficient heat is applied the two substances combine with great energy. However, the amount of heat necessary to cause this combination differs according to the form of carbon used. Thus, lamp-black requires much less heat than charcoal, more heat will be required to ignite coke, more still for anthracite coal, yet more for diamond, and, as regards graphite, we can scarcely produce heat enough to ignite it. The comparative incombustible nature of the last named substance, renders it suitable for crucibles for melting brass and other metals or alloys. All these substances are only carbon in different states, called allotropic conditions.

At the same time that the combustion commences to take place, it develops new heat in abundance, heating up the adjacent parts to the temperature required for combination in their turn, and so keeping up the heat to cause the final combustion of any amount of carbon and oxygen present. In the place of carbon, sulphur or any other so-called combustible substance may be substituted.

Combustion, therefore, is nothing but a chemical combination of a so-called combustible substance (carbon, sulphur, hydrogen, phosphorus, etc.), usually with the oxygen of the atmosphere; all that is required to start it, is a sufficient rise of temperature, and any large conflagration gives a striking illustration of the considerable development of heat, which is the result.

By the combustion of carbon, every six parts thereof will unite with sixteen of oxygen, when plenty of oxygen is present; by a limited supply of this last substance, it will only combine with eight parts; and, as the symbol C stands for six parts of carbon and O for eight of oxygen, the product of this combustion is expressed in the first case by CO_2, in the last by CO; and as the first possesses acid properties it is called carbonic acid, and the last possessing no such properties is called carbonic oxide; the last being the generic name for all combinations with oxygen which possess no acid properties.

The combustion of sulphur has for result, the combination of sixteen parts of sulphur with sixteen of oxygen; formula, SO_2, named sulphurous acid.

Selenium and tellurium combine after the same law and with similar results as sulphur, except that the respective numbers of combination are 40 and 64, respectively with sixteen of oxygen; formulæ, SeO_2 and TeO_2.

The combustion of hydrogen has for result a compound of one part of hydrogen (always by weight) with eight of oxygen, forming water; formula, H O.

The combustion of phosphorus forms phosphoric acid; formula, PO_5, which means thirty-one parts of phosphorus and forty of oxygen.

The combustion of potassium forms potassa; formula, K O, which means thirty-nine parts of the metal and eight of oxygen.

Magnesium burning forms magnesia; formula, Mn O, or thirteen parts of magnesium and eight of oxygen.

Zinc burning forms oxide of zinc or zinc white; Zn O containing thirty-two parts of zinc and eight of oxygen.

Of all the substances mentioned above, there is none that has more affinity for oxygen than red hot carbon; for this reason carbon is used as the great reducing agent, and almost any oxidized substance mixed with carbon and heated, will give its oxygen to the carbon, and carbonic acid will be formed. On this principle depends the reduction of iron from its ores, the manufacture of potassium, sodium, etc.; and it shows that also in chemistry the law of the strongest prevails, just as in all nature, not excepting the human race. In savage nations, brute strength only prevails, but among civilized people, the strength of mind and knowledge subdues the mere material brute forces, and illustrates the superiority of mind over matter.