Col. XIII. exhibits the differences between the experiments of the French Academy and the Franklin In­stitute.

Col. XIV. exhibits the deviations of Tredgold’s formula from Dalton's experiments, down to 240° ; and be low that point, from the mean of the experiments of the French Academy and the Franklin Institute, in terpolated where required.

Col. XV. exhibits the difference between our formulæ and the best experiments, Dr Dalton’s being taken down to 240° ; and the mean between those of the French Academy and the Franklin Institute from that point to the end of the table—interpolations being used when necessary.

SECTION IV. ON THE CONSTITUTIONAL CALORIC OF

STEAM, ITS DENSITY AND VOLUME AT DIFFERENT TEMPERATURES, AND ITS GENERATION AND CONDENSATION.

57. Having now ascertained the force that may he given to steam by heating water in a confined space, so that we can always obtain any force we desire by raising it to the proper temperature, we have next to enquire what quantity of heat is necessary to produce steam of that temperature and force. The answer to this question is, to determine the quantity of fuel necessary to generate steam of a given power, and direct the economic application of that power.

The quantity of caloric necessary to transform a given quantity of water into steam of the same temperature, is called the *caloric of elasticity* of that substance. The quantity of heat which it will contain at any given temperature is called its *capacity* for heat ; and the relation which subsists between the quantity of heat which some well known body, such as water or air, gives out or ac quires, in a given change of temperature, and that which any other substance will give out or acquire in the same circumstances, is called the *specific caloric* of that sub stance.

58. Of the quantity of the caloric of elasticity of any sub stance, of its capacity for containing heat, and of its specific caloric, the *thermometer* gives us no information. An instrument for doing so may be called, as a distinction, the *calorimeter.* Thus the thermometer measures the in tensity of heat—the calorimeter its quantity.

If in three several vessels there be contained, at the temperature of 32°, a pound weight of three different fluids, water in one, mercury in the second, and oil in the third ; and if the heat of an alcohol lamp be applied, first of all to the mercury, then to the water, and next to the oil, a thermometer being inserted in each, it will re quire much longer time to heat the water to 212° of the thermometer than the mercury, twenty-five times as much alcohol being burnt in the process ; whereas the oil will be wanned to the same temperature on the thermo meter, by half the quantity of calorie which is necessary to heat the water to 212°. Therefore, the capacity of water for heat is said to be twenty-five times as great as that of mercury, and twice as great as the capacity of oil ; and the specific heats of these substances, in relation to water, are thus represented :

Water, 1.000; oil, 0.520; mercury, 0.040 nearly.

If, instead of taking equal weights of these substances, wo had filled equal vessels with them, and then applied the quantity of water necessary to heat them to equal temperatures, we should have had the capacities and specific heat of equal volumes, instead of equal masses as formerly ; and it would have been found, that the quantity of alcohol required to heat them to the same temperature, was only half as much for the mercury as the water, and greater for the water than the oil, in the proportion of 20 to 9 ; showing that the capacity of water was still the

greatest, and that the specific caloric, in equal volumes of these substances, are nearly

Water, 1.000 ; oil, 0.450; mercury, 0.550.

The capacities for heat, and the specific caloric of different substances, may be determined by cooling as well as heating them. An ounce of ice thrown upon a pound of mercury will cool it or an equal weight of oil much more than water ; and, in general, the quantity of ice, or of cold water, or of cold air, or any other fluid required to cool a body, will exactly correspond to the quantity of caloric required to heat it to the same degree of temperature. A calorimeter measures the quantity of ice which must be melted in cooling different substances, and is de scribed in our article “ Ηεατ.” The following are the results of such of the most valuable experiments upon this subject as are appropriate to our present enquiry :

Table of the specific Calorie in different substances.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Equal | Equal |  |
|  | Weights. | Volumes. |  |
| Water, .... | 1.000 | 1.000 |  |
| Mercury, .... | 0.033 | 0.470 Dulong and Petit. | |
| Alcohol, .... | 0.700 | 0.570 Dalton. |  |
| Sulphuric ether, . | 0.660 | 0.500 Dalton. |  |
| Spermaceti oil, | 0.520 | 0.450 Dalton. |  |
| Olive oil, .... | 0.309 |  | |
| Sulphuric acid, | 0.350 | 0.650 Dalton. |  |
| Nitric acid, . . . | 0.620 | 0.870 Dalton. |  |
| Muriatic acid, . . | 0.600 | 0.700 Dalton. |  |
| Sol. of salt (1.197) | 0.780 | 0.930 Dalton. |  |
| Sol. of sugar (1.117) 0.770 | | 0.900 Dalton. |  |
| Ice, | 0.900 | 0.830 Dalton. |  |
| Coal, | 0.280 | 0.360 Dalton. |  |
| Flint glass, . . . | 0.190 | 0.550 Dalton. |  |
| Iron, | 0.110 | 0.880 Dulong and Petit. | |
| Copper, . . . . | 0.095 | 0.850 Dulong and Petit. | |
| Lead, . . . . . | 0.040 | 0.450 Dalton. |  |
| Tin, | 0.070 | 0.510 Dalton. |  |
| Zine, | 0.100 | 0.690 Dalton. |  |
| Silver | 0.055 | Dulong and Petit. | |
| Gold, | 0.029 | Dulong and Petit. | |
| Platina, . . . . | 0.335 | Dulong and Petit. | |
| Atmospheric air, | . . 0.267 1.000\* 1.000\* | |  |
| Hydrogen gas, . | . . 3.294 12.340 8.903 | |  |
| Oxygen gas. . . | . . 0.236 0.885 0.976 | |  |
| Nitrogen gas, | . . 0.275 1.032 1.000 | |  |
| Nitrous oxide gas, | . . 0.237 0.888 1.350 | |  |
| Olefiant gas, . . | . . 0.420 1.576 1.553 | |  |
| Carbonic oxide gas, | . 0.288 1.080 1.034 | |  |
| Carbonic acid gas, | . . 0.221 0.828 1.258 | |  |

69. Besides the capacity of different bodies for heat, and the specific heat of each at given temperatures, there is another condition of heat still more striking, and of which the thermometer gives no indication. It is this : that the same substance, at different times, may contain different quantities of caloric, and yet the thermometer in both cases give the same indication of temperature. Ice at 32°, which is in the process of melting, and while its bulk is diminishing by one-tenth part, receives as much caloric as would raise its temperature, when melted, to 172°; and after having received it all, remains still at the same temperature as before, indicating 32° on the thermo meter. In like manner, when the particles of the water have acquired so much sensible heat os to raise its temperature to 212°, it may receive as much more heat as would have raised its temperature 950° or 960°, if it had continued to be shown by the thermometer; but the water now assuming the state of steam, the thermometer indicates no accession, but remains in the water or in the steam still at the temperature of 212°. In these two conditions, there

\* In these two columns air is assumed as unity, the first being the specific heat under equal weights, and tile second under equal volumes.