TABLE I.

Warm Area.						Cold Area.						
Series 87.		Station No.	Depth.	Surface Temperature.	Bottom Temperature.	Series 64.		Ser. 52	Station No.	Depth.	Surface Temperature.	Bottom Temperature.
Depth.	Temperature.					Depth.	Temperature.	Temperature.				
f.h.	°		fths.	°	°	fths.	°	°		fths.	°	°
0	52·6					0	49·7	52·1				
50	48·1	73	84	52·7	48·8	50	45 5	48·5	70	66	53·4	45·2
		80	92	53·2	49·4				69	67	53·5	43·8
100	47·3					100	45·0	47·3	68	75	52·5	44·0
		71	103	53·0	48·6				61	114	50·4	45·0
		81	142	53·3	49·1				62	125	49 6	44·6
150	47·0	84	155	54·3	49·2	150	43·3	46·5	60	167	49·5	44·3
		85	190	53·9	48·7				IX.	170	52·0	41·0
200	46·8					200	39·6	45·6				
		74	203	52·5	47·7							
						250	34·3	38·4				
300	46·6					300	32·4	30·8				
									63	317	49·0	30·3
									65	345	52·0	29·9
									76	344	50·3	29·7
		50	355	52·6	45·2	350	31·4	..	54	363	52·5	31·4
		46	374	53·9	46·0	384	..	30·6				
400	46·1					400	31·0	..	86	445	53·6	30·1
		89	445	53·1	45·6	450	30·6	..				
		90	458	53·1	45·2				56	480	52·6	30·7
		49	475	53·6	45·4				53	490	52·1	30·0
500	45·1					500	30·1	..	X.	500	51·0	30·8
		VI.	530	52·5	44·8				58	540	51·5	30·8
·		47	542	54·0	43·8				VIII.	550	53·0	29·8
		XV.	570	52·0	43·5	550	30·1	..	77	560	50·9	29·8
									59	580	52·7	29·7
600	43·0					600	29·9	..				
		XVII	620	52·0	43·5				55	605	52·6	29·8
·		XIV.	650	53·0	42·5				57	632	52·0	30·5
						640	29·6	..				
700												
		88	705	53·5	42·7							
767	41·4											

TABLE II.

Serial Soundings								Bottom Soundings.			
Depth.	Temperature. Ser. 23.	Temperature. Ser. 42.	Temperature. Ser. 22.	Temperature. Ser. 19.	Temperature. Ser. 20.	Temperature. Ser. 21.	Temperature. Ser. 38.	Statn. No.	Depth.	Surface Temperature.	Bottom Temperature.
fths.	°	°	°	°	°	°	°		faths.	°	°
0	57·3	62·6	56·9	54·8	55·5	56·2	64·0				
50	..	53·2						27	54	55·6	48·3
								34	75	66·0	49·7
								6	90	54·0	50·0
								35	96	63·4	51·3
100	48·5	51·1						8	106	54·2	51·2
								24	109	57·7	46·5
150	..	50·9						7	159	53·2	50·4
								14	173	53·2	49 6
								18	183	53·2	49·4
200	48·0	50·5						13	208	53·6	49·6
250	..	50·2	48·5	48·0	48·5	48·3	50·5	4	251	53·5	49·5
300	47 8	49·6									
350	..	49·1						1	370	54·0	49·0
400	47·5	48·5									
450	..	47·6						15	422	52·2	47·0
								45	458	60·7	48·1
500	45·8	47·4	46·7	46·7	46·9	47·5	47·8				
								40	517	63·4	47·7
550	..	46·4									
600	44·5	45·5						41	584	63·4	46·5
630	43·4										
650	..	44·3									
700	..	43·6						12	670	52·2	42·6
								3	723	54·5	43·0
								36	725	63·9	43·9
750	..	42·5	42·0	41·2	41·6	42·4	41·3				
800	..	42·0									
								2	808	54·1	41·4
862	..	39·7						16	816	53·0	39·5
900								44	865	61·2	39·4
1000	..	..	38·8	38·5	38·8	38·5	38·3				
1200								43	1207	61·7	37·7
1263	..	..	37·3								
								28	1215	57·7	37·1
1250	..	..	..	..	37·7	37·9	37·7	17	1230	53·2	37·8
1300								29	1264	56·9	36·9
1360	..	..	..	37·4							
1400											
1443	..	..	..	..	37·0			32	1320	55·9	37·4
1450								30	1380	56·0	37·1
1476	..	..	..	..	..	36·9					
1500	..	..	..	..	..	..	37·2				
1750	..	..	..	..	..	..	36·7				
2090	..	..	..	..	..	..	36·3	37	2435	65·6	36·5

PHYSICS

Mechanical Theory of Heat

WE translate the following passages from a paper by Dr. Meyer, of Heilbronn :—

It has been inferred from the meteorite theory, which supposes the sun to derive its heat from the impact of planeto-kosmic masses, that the entire machine of creation must eventually come to a standstill. I gladly seize the opportunity which now offers itself, to state that I do not share this view. The doctrine of the development of heat by the collision of spatially separate masses, has but just arisen, has therefore advanced but little, and cannot yet serve as an appropriate foundation for so comprehensive a consequence. I will briefly state what may be said, from my own point of view, as to the stability of the universe. Its final cessation will occur, when all the ponderable matter it contains is combined in a single mass; whereupon, as we may readily perceive, the whole of its existing *vis viva* would be uniformly distributed in the form of heat throughout the mass, which would thus attain an eternal equilibrium.

But how could such a combination happen? Five years have passed since Brayley, of London (and Reuschle just recently in a number of the German quarterly journal), stated, that if masses of the magnitude of our sun, or only half as great, were to come into collision, so enormous would be the effect, that all cohesion would be at an end, and the molecules would fly off into infinite space. Now we have every reason to suppose that, in the ceaseless course of time, and in an unlimited expanse, this kind of destruction or partial ruin of worlds has taken place, and is actually in progress. We have a striking proof of it in the observation of meteorites with a hyperbolic path. On this point I would refer to the important memoir of Prof. Heis, of Münster. "The large fire-ball which was seen on the evening of March 4, 1863, in Holland, Germany, Belgium, and England (Halle, 1863)." The true heliocentric motion of this meteorite amounted to 9.145 geographical miles per second. A body lying between the earth's orbit and the sun, and owing its motion solely to the attraction of the latter, cannot have a greater rate than 5·8 geographical miles; so that the fire-ball above referred to must have entered the sphere of attraction of our sun with an initial velocity of 7 geographical miles per second. Now, whence could it have derived such a motion?

In order to throw light on this question, we might imagine a peculiar progressive movement of the whole solar system in space, or have recourse to a movement round a so-called central sun. But we cannot suppose any such accumulation exists sufficiently large to confer an appreciable velocity on our sun at the distance of the fixed stars. Moreover, if our earth possessed a distant motion towards space in addition to its centripetal motion towards the sun, the light which reaches it from the fixed stars would present phenomena of aberration different from those actually observed. Were this proved, meteors with a hyperbolic path would be so many fiery couriers, living witnesses of a conflict somewhere and sometime happening in strength sufficient to explode and scatter the molecules in every direction. If we also consider that the radiating power of the sun's body, as of all the fixed stars, is connected with the consumption of collided masses, yet that consumption has not therefore ceased, since throughout the disturbance, large masses of debris continually reach our world.

All the phenomena of terrestrial motion, except volcanic action and the ebb and flow of the tides, are eventually derived from the sun. One of these, which we are about to consider more particularly, is an electric current on the surface of the earth. That it actually exists is evident from the direction of the magnetic needle, as also from the immediate observations of Lamont. But as there can be no action without corresponding cause, it follows that this remarkable expenditure of electric effort must be attended with as large a compensation. We have, then, to consider our earth as being, in this respect, a huge and permanently efficient electric machine. I do not here refer to the local phenomenon of thunderstorms.

For a constant source of the constant disturbance of electrical equilibrium in the earth's body, we can only have recourse to the unceasing flow of air between the tropics, known under the name of the trade-winds. The lowest layer of the trade-wind assumes, by friction on the surface of the sea, an opposite electrical condition. This air, however, heated by the sun, and dislodged by the colder current setting beneath it, rises and directs its course to the poles, where its high electric tension originates the beautiful phenomenon of the aurora. It must now be observed that, on account of the physical condition of the earth's surface, the electromotor activity of the southern hemisphere must be throughout much stronger than in the northern; whence it happens, that not only on both hemispheres between pole and equator, but also between the north and south poles themselves, a continual disturbance of electric equilibrium occurs; and it is this by which the direction of the needle is determined. The narrow belt between the north and south-east trades—called by Dove the zone of calms—may be termed, for present purposes, the meteorological equator. This is known not to coincide with the geographical equator, but to oscillate slowly about a limit of 1 to $1\frac{1}{2}$ degrees north of it. The *experimentum crucis* for the theory—or, as we will only term it at present the hypothesis—here adduced of the trade-winds as the source of terrestrial magnetism, would consist in establishing that the known alterations which the magnetic pole, as well as declination, gradually undergo, are accompanied by parallel changes of our magnetic equator. But work of this description cannot be accomplished by a single private individual, and I must content myself with having brought the subject forward.

Amagat on the law of Mariotte

PROFESSOR E. H. AMAGAT has published the results of some experiments, still in progress, on the influence of temperature on departures from the law of Mariotte. The researches of Regnault have shown that this law is not rigorously obeyed by any gas excepting hydrogen; in all other cases compressibility increases with pressure, that is, when the gas approaches its temperature of ebullition. This phenomenon has received various explanations. It has been considered as resulting from reciprocal molecular attraction; it has also been elucidated by a theory which was first enunciated by Daniel Bernouilli, but has received successive additions at the hands of Joule, Krœnig, and Clausius. The theory in question takes into account not only the movements of translation of molecules, but their rotatory and internal movements, as well as the possible movements of imponderable fluids. If we admit the first explanation, then, as attraction only depends on the mean distance of the molecules, the departure from the law in any single case must be the same at any temperature, provided the initial and final volumes are the same. In other words, let V be a given volume of gas at the temperature t and pressure p. Reduce this volume to V′ by a pressure p',′ the temperature remaining unchanged. On heating the gas to t, it will expand; let P be the pressure necessary to restore the volume to V, and P′ the corresponding pressure. If the departure be only a function of the volume, it is clear that we must have

$$\frac{pV}{p'V'} = \frac{PV}{P'V'}.$$

As $\frac{V}{V'}$ is common to both sides of this equation, it is only necessary to compare $\frac{p}{p'}$ with $\frac{P}{P'}$. The author has done this in the case of sulphur dioxide, ammonia, and carbon dioxide. In the instance of sulphur dioxide—

$$\left.\begin{array}{l}\text{at } 14^\circ,\ \frac{p}{p'} = 0{\cdot}50838 \\ \text{at } 98^\circ,\ \frac{P}{P'} = 0{\cdot}50277\end{array}\right\}\ \text{difference, } 0{\cdot}00561.$$

(This difference corresponds to an observed height of more than one centimetre of mercury.) For ammonia—

$$\left.\begin{array}{l}\text{at } 13^\circ,\ \frac{p}{p'} = 0{\cdot}50731 \\ \text{at } 97^\circ,\ \frac{P}{P'} = 0{\cdot}50402\end{array}\right\}\ \text{difference, } 0{\cdot}00329.$$

For carbonic dioxide—

$$\left.\begin{array}{l}\text{at } 13^\circ,\ \frac{p}{p'} = 0{\cdot}50981 \\ \text{at } 97^\circ,\ \frac{P}{P'} = 0{\cdot}50402^*\end{array}\right\}\ \text{difference, } 0{\cdot}00210.$$

It appears from the preceding numbers that the departure is not only a function of the volume, but also of the temperature at which the experiment is performed. This result agrees, however, with the second theory. In fact, the *vis viva* of the molecules being greater as the temperature rises, it may be readily conceived that the loss due to their collision is relatively smaller than the augmentation of pressure on the walls of the enclosing vessel, due to the augmentation of *vis viva*, this being true even when, as the rate is accelerated, the molecular collisions become more numerous.

* This number is obviously a misprint.

In a new series of experiments, M. Amagat kept the initial and final pressures as nearly as possible the same in each case, thus obtaining the influence of temperature alone. He then arrived at the following general results:—

1. That near 100°, sulphur dioxide and ammonia depart but little from Mariotte's law, yet more so than air at the ordinary temperature.
2. That near 100°, carbon dioxide is almost a perfect gas.
3. That near 100°, air exactly follows the law.

The author is convinced that the higher the temperature of liquefaction of a gas is found to be (under the same pressure), the less does it depart from the law of Mariotte at the same distance from its point of liquefaction. *—[Archives des Sciences physiques et naturelles, 139, p. 169.]

* With the above results compare those obtained by Andrews (Proceedings of the Royal Society, xviii. 42).

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, March 17.—Mr. Carruthers exhibited a section of a fossil *Osmunda* from the eocene beds of Herne Bay, in which not only the forms of the cells were preserved, but the contents of the cells, and even the starch-granules. Before its conservation it had been attacked by a parasitic fungus, the mycelium of which is preserved, in precisely the same condition as it would be in a recent specimen.—Dr. Hooker read a further communication from Sir Henry Barkly on the Flora and Fauna of Round Island. The highest point of the island is 1,049 feet above the level of the sea; the summit is smooth, with three large and remarkable blocks of granite. It is entirely composed of tufa, mixed with volcanic sand in perfectly preserved strata. The deeper ravines are crowded with lofty palms. Of the twenty-six flowering plants gathered, the greater number belong to the orders *Gramineæ*, *Pandanaceæ*, *Palmaceæ*, *Ebenaceæ*, *Cinchonaceæ*, *Compositæ*, and *Asclepiadeæ*. The proportion of Endogens to Exogens is very large, namely, twelve to fourteen; but this proportion by no means represents the enormous preponderance of the former in individuals, probably amounting to 99 per cent. Some of the Exogens are specifically identical with those of the Mauritius, but few of the Endogens; those of the former class which are common to the two islands have probably been introduced at some remote period. Of the three cryptogamic plants observed, one was a moss, probably a *Sphagnum*, one a *Selaginella*, certainly a new species, and one a widely-spread fern, *Adiantum caudatum*. Of the five grasses the most abundant is identical with the Indian Lemon-grass. The *Cyperaceæ* are represented by one species, *Scirpus maritimus*. The *Pandanaceæ* are very remarkable; *Pandanus utilis* occurs, but in one spot only, rare, and no doubt introduced, whilst the other, an allied species (*P. Vandermeerckii*, is quite peculiar to the islet). Of Palms there are no less than three species, probably all peculiar, the most remarkable being the bottle-stemmed species (a *Hyophorbe*) already described as peculiar to the island. The only other Endogen belongs to the order *Liliaceæ*, and is an aloe, growing on the summit, and probably a new species. Of *Ebenaceæ* there are three species, and two Asclepiads with trailing stems; one species of *Myrsineæ*, new; two *Compositæ*, one of them a *Sonchus*, both probably introduced; one species of *Combretaceæ* and one of *Myrtaceæ;* two *Cinchoneæ*, and a small tree about twelve feet high, resembling the *Blackwellia* of Mauritius. It will be seen that while the genera of the Round Island Flora are Mauritian, the species are mostly peculiar. It is probable that the whole group of islands—Mauritius, Bourbon, Round Island, Ile de Serpents, Rodriguez, with the smaller islets, and probably Madagascar—are fragments of a vast continent. As regards the Fauna, there are no indigenous mammalia, although goats and rabbits have been introduced and have multiplied exceedingly, and no land birds, not even the Mauritian pigeons. The island seems, on the other hand—perhaps from the absence of mammalia and birds—very favourable to reptile life. Of Chelonians, a female land-tortoise had previously been captured on the island. Four distinct Saurians were found, the largest exceeding a foot in length, a native of