Ephemeris 12h. Berlin.

1906	α (true)	δ (true)	1906	α (true)	δ (true)
	h. m. s.	° ′		h. m. s.	° ′
Nov. 20 ...	10 0 55 ...	24 28·1	Nov. 28 ...	10 41 34 ...	34 10·6
24 ...	10 20 51 ...	29 24·7	Dec. 2 ...	11 2 57 ...	38 38·5

The brightness of this object is now decreasing, and will be 1·04 times that at the time of discovery on November 24, when its magnitude was 8·5 (Kiel Circular, No. 92). In announcing the discovery of this comet last week, it was stated that the magnitude was not given in the Kiel telegrams. Prof. Kreutz writes to point out that the magnitude was given; and we regret that the group of figures containing it was mistranscribed whilst decodifying the message.

HALLEY'S COMET.—In vol. cxv., part v., of the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*, Dr. J. Holetschek discusses the probable time at which Halley's comet may be looked for with reasonable chance of success during its forthcoming return. By reason of a particular combination of perturbations, the present period of revolution (74½ years) is the shortest observed since 1531, but after determining the comet's distance from the earth and the sun during the oppositions of 1906–9, Dr. Holetschek concludes that there is no great likelihood of this object being re-discovered before the latter part of 1908. At the end of 1909 it should certainly be easily observable, and during the second half of March, 1910, it should become a naked-eye object. According to the elements published in the *Connaissance des Temps* (1900), the comet is due to pass through perihelion on May 16, 1910.

A BRIGHT METEOR.—An exceptionally beautiful meteor was observed by Mr. Rolston at the Solar Physics Observatory, South Kensington, at 13h. 26·5m. on November 17. The approximate positions of the beginning and end of the trail were $\alpha=75\frac{1}{2}^\circ$, $\delta=+24^\circ$, and $\alpha=88^\circ$, $\delta=+14^\circ$, respectively. The narrow, fan-shaped head was nearly as bright as Jupiter, and left behind it a shimmering trail of a reddish colour, similar in appearance to the shower of sparks which come from a suddenly-braked train wheel. The duration of the meteor's flight was little more than one second, and the trail died away immediately.

THE UNITED STATES NAVAL OBSERVATORY PUBLICATIONS.—We have received from the U.S. Naval Department a copy of part iv., vol. iv. (second series), of their Publications, containing, in addition to a profusely illustrated account of the 1900 and 1901 eclipse expeditions, previously described by Dr. W. J. S. Lockyer (NATURE, vol. lxxiii., p. 486, March 22, 1906), a number of tables for use in the reduction of astronomical observations. The reduction tables for transit-circle observations contained in part ii. are only suitable for the Naval Observatory, with the exception of the refraction tables, which are based on the Pulkowa values.

Part iii. contains reduction tables for equatorial observations, including those for differential refraction and instrumental corrections. In part iv. there is a very interesting discussion of the present status of the use of standard time, in which a fairly complete account of the standard times in use in every part of the earth is given.

The conversion tables, and the summaries of the time in each country, giving the standard meridians and the relation to the standard times of other countries, should prove very useful for reference purposes.

THE ACTION OF TRAM-CAR BRAKES.

THAT steep gradients can be overcome by mechanically-propelled tram-cars—as compared to ordinary railway trains—and that street-cars are driven on public thoroughfares, more or less crowded with other traffic, renders the brake question one of considerable importance. The lamentable accident that occurred at Highgate last June affords strong evidence of this. On June 23 a double-deck bogie car became unmanageable, and ran at a great pace for a distance of about three furlongs down the hill extending southwards from Highgate Archway to the Archway Tavern. The gradients here, though considerable, are not excessive for tramway work when the cars are operated with due care. The lines have an inclination of about 1 in 22½ on the hill, but in other parts of the line the gradient is 1 in 18, whilst gradients of 1 in 9 have been authorised. Colonel Yorke, to whose full and admirable report on the accident we shall make frequent reference, has said that the Board of Trade insists on track brakes being fitted to all cars running over gradients of 1 in 15, the speed being limited to six miles an hour. Of the passengers on the car, only a few were slightly injured, but three persons in the street were killed and twenty were injured, some seriously. The runaway car collided with a hearse, a furniture van, a motor-omnibus, and another van, being finally brought to rest by a stationary car at the terminus. The chief lesson to be gained from the disaster is connected with the action of brakes on vehicles of this description.

The car would carry thirty passengers inside and thirty-eight on the top. It was of the double-bogie type, with eight chilled cast-iron wheels and maximum-traction trucks, the small wheels leading. There was a 35-h.p. motor on each bogie truck, the motors being geared to the axles of the large driving wheels. The general design appears, from the descriptions given in Colonel Yorke's report, to be of a well-known type in which the effort is made to get the maximum weight for adhesion on the driving wheels without the use of a motor on each axle, the latter being an arrangement which, with a double-bogie car, would need four motors. With this design the distribution of weight becomes a matter of great importance. The car in question weighed twelve tons unladen, and the engineer to the owners, the Metropolitan Electric Tramway Company, has estimated that four tons were carried upon each of the driving axles, and two tons upon each of the pony axles.

The car had hand brakes, of the usual description, working brake blocks on all eight wheels, and was also fitted with electromagnetic track brakes having two shoes on each bogie. There were also four sand-boxes operated from the driving platform.

The track brake has been introduced at a comparatively recent date, and is especially for tramway work. Its failure to stop the car in the instance under consideration is therefore a circumstance worthy of close inquiry. There are two leading descriptions of electromagnetic track brake or slipper brake, but Colonel Yorke's report does not specify the type fitted, although the description fairly well indicates which was used. There are certain features common to both types, and each acts by the brake shoes being strongly attracted to and pressed on the rails by magnetic force. The magnets formed by the brake shoes are energised by current generated by the car motors. Colonel Yorke gives a concise description of the brakes on the car under notice. Each brake shoe consisted of two narrow steel plates 15 inches long, placed side by side, with a small interval between them, thus forming the poles of a powerful electromagnet, excited by current supplied by the motors acting as generators. The shoes of the brakes in question were also connected to the brake blocks which formed part of the hand brakes, so that the latter pressed against the wheels, and therefore automatically came into play when the track brakes were applied. This is a usual arrangement. With electromagnetic brakes of this description there is a retarding action due to the motors running as generators, and therefore putting a braking action directly on the axles. It will be understood that the hand brakes can be operated without putting the magnetic brake in action. Resistances are provided between the motors and the magnets so as to regulate the current in the latter. In this way magnetic adhesion can be controlled at will. It is further claimed that an advantageous effect is produced by the pressure on the rails by the wheels, due to the attraction of the magnets. The electromagnetic brake clearly supplies a most important means for checking the speed of a car. Colonel Yorke describes it as "one of the most modern, and, when properly used, one of the most effective devices for controlling tram-cars."

The car had been recently overhauled, and was apparently in good condition. New brake blocks had been fitted to the driving wheels, the clearance being 1/16th of an inch when off The driver stated that one of the sanders was

not in good condition, but there appears to have been some doubt on this point; in fact, the balance of evidence is that the driver was mistaken. The driver also stated that he had had trouble with his hand brakes previously to the accident; the wheels, he said, seemed to skid directly the brakes were applied, and, when released, did not immediately revolve even when sand was used.

It was a regulation of the company that all cars should be brought to rest at the top of the hill, but when the driver attempted to stop his car with the hand brake the wheels skidded, owing, as he said, to the rails being greasy from having been recently watered. Upon this he released the hand brake and tried the magnetic brake, but as the wheels continued to revolve the magnetic brake was useless, and the result was that the car ran past the Archway without stopping, and came on to the gradient of 1 in 22. The speed having increased so that the car was getting beyond control, the driver signalled to the conductor to apply his hand brake, but this having no effect the conductor released it again. The driver then reversed his motor, thus causing the automatic switch to blow, after which he moved the controller handle to the position in which the motors would generate current against each other in order to produce a powerful braking action. These efforts, however, had little effect on the speed of the car, which dashed down the hill, with the terrible results before mentioned, until brought to rest by running into the empty car at the bottom of the hill. Before this the driver had jumped off, abandoning the car to its fate, his desertion being more disastrous as there was no one to ring the bell, a circumstance which, in Colonel Yorke's opinion, led to the large number of persons being injured. The fact seems to suggest the need of an automatic continuous striking bell which would be put in operation only upon emergencies. This would have the additional advantage of relieving the driver of one operation at times when he would be hard pressed.

It will be gathered from what has been said that the electromagnetic brake is only brought into play when the motors are acting as generators, and therefore it evidently cannot be used when current is being supplied to the motors from the overhead conductor. The motors become generators through the action of the road wheels, and, therefore, as soon as the latter cease to revolve the current required to energise the brake magnets ceases to be generated. This is the weak point of the arrangement, for if the hand brakes are put too hard on the wheels will skid, or be locked, and the rail brake become useless. The loss of the assistance of the magnetic brake owing to the skidding of the wheels is more serious because the fact of skidding reduces very greatly the retarding effect of brakes upon a car.

The experiments made in 1878 on the Brighton Railway by Sir Douglas (then Captain) Galton, Mr. Stroudley, and Mr. Westinghouse are fairly well known to railway engineers. Apparatus was designed by Mr. Westinghouse by means of which, through water pressure and Richards indicators, there were recorded the retarding force which the friction of brake blocks exerted on wheels, the force with which the blocks pressed against wheels, and the force required to drag the van. These experiments clearly proved that when the wheels of a car are skidded, or blocked by the brakes, the retarding effect is very much less than when the brake shoes are pressed on the wheels with a force just short of that needed to cause skidding. The fact was known previously; indeed, in 1846 Mr. J. V. Gooch issued an order to the men on the South-Western Railway that wheels were not to be skidded; and the result might have been deduced from the experiments of Prof. Fleeming Jenkin on the effect of friction.

Although a skidded wheel does not afford the same resistance to the forward movement of the car as does one which continues to revolve, yet the brake shoes must be pressed on to the wheel with sufficient force to produce an effective braking action. This action is by far the most effective just at the instant that skidding commences, there being then a very sudden rise in tangential resistance. Just at the moment the brakes are released—the wheels being skidded—there is another rise in tangential force caused by the brake blocks. Prof. Fleeming Jenkin's experiments on the effect of friction at different speeds may be consulted with advantage in connection with these results. Although the ordinary brakesman does not carry out quantitative experiments by the aid of elaborate apparatus, he finds by experience that his brakes are most effective when the critical point is approached. The most skilled men will manipulate their brakes with great effect, getting the greatest retarding action for the car without skidding the wheels. The best way in which to work brakes, therefore, is to apply a considerable force at first, releasing it as the skidding point is almost reached.

Another point in connection with brake action, which almost follows from what has been said, is that although a good deal of pressure on the blocks is needed to make a wheel skid, a comparatively moderate force is needed to keep the blocks on when the wheels have once stopped revolving. Still another point bearing on the question under consideration is the decrease of friction that takes place with increase of speed of movement between rail and wheel. This is contrary to what is observed with lubricated surfaces, but, as Sir Alexander Kennedy has pointed out, it bears out the smaller experiments of Prof. Fleeming Jenkin. On the Brighton Railway Company's trials the effect was clearly proved. The experimental van was drawn alone by a powerful express engine, and was thus able to maintain a high speed with the brake on, and it was clearly shown that there was greater adhesion between rails and skidded wheels at high speeds than at low speeds. In some cases the tangential-force diagrams showed a rise in adhesion of 100 per cent.

The bearing of these facts on the present case is plain. That a driver of a car will go as near skidding as possible is apparent, and an unskilled man will often pass the critical point. Then the wheels will cease to revolve, and no current will be generated to energise the electromagnet; consequently the rail brake will be out of action, and, as a skidded wheel does very little to check the momentum of the car, all the elements of a serious catastrophe are present when descending any considerable incline. Beyond this, the rail brake cannot hold a car stationary on a hill when once it has been brought to rest.

These defects would be overcome if the main current from the overhead conductor were available for energising the electromagnet. This would introduce some complication and extra fittings, but there does not appear to be any insuperable difficulty. The fact that the present electric-rail brake is liable to fail just when it is most needed—as shown by the Highgate tragedy—and the remembrance of the terrible results of a heavy car rushing down uncontrolled amongst traffic, make it plain that considerable sacrifice is warranted if the powerful rail brake can be brought more readily into play at a time when it is most efficient, namely, before the travel of the car has acquired a high velocity.

The particulars we have already of the accident form a practical illustration of the bearing of the experimental data collected on the Brighton Railway trials. Whether the skidding of the wheels of the car—which undoubtedly took place, as flats were afterwards found on the tread of the wheels—was due to want of skill on the part of the driver or to injudicious rigging of the brake is a matter of interest rather than importance, for drivers are as liable to be flurried or unskilful as brakes are likely to be improperly rigged. In regard to the first proposition, the driver's training in the present case consisted of eleven lessons of about one hour each in a school, and twelve lessons on the road. This appears to have been considered sufficient instruction to entitle the driver to hold a certificate of "thoroughly instructed in the duties of a motor-man and now competent to take charge of a car." After that he had three days' practice on the Archway route with another motor-man, including one day's instruction with the motor brake. He had been in regular work for twenty days at the time of the accident.

We are not aware whether this driver had had any mechanical training, or had been employed about the mechanism of motor vehicles, before he began his driving career, but if not the course of instruction appears insufficient. This was borne out by his evidence at the inquest, for he was not aware that the magnetic brake

acted independently of the current from the trolley-wire, a fact quite sufficient to account for him attempting to apply the magnetic brake when the wheels were skidded. In regard to the hypothesis that the accident was due to improper fitting of the hand brakes, Colonel Yorke says that the shoes, which cleared the wheels 1/16th of an inch, as stated, were new and of cast-iron. The rubbing surface would therefore have the rough skin characteristic of iron castings, and friction would be greater than when the blocks had been worn smooth by use. A very slight pressure would cause the wheels to skid, and as the springs which pull the brake off had only 1/16th inch compression, the brake might remain on after the driver had moved the brake lever to the release position. The position of the brake blocks, in regard to the vertical component, may also have had an effect in keeping them on, as Colonel Yorke points out in his report. The blocks were hung so that they would be below the centre of the wheels, and therefore the upward movement of the periphery of one wheel in each pair would tend to force the brake on when once it had made contact. Colonel Yorke very properly condemns this arrangement, as it prevents the brakeman from using any nice adjustment such as is needed to prevent the wheel from skidding. Sir Douglas Galton, in his paper before the Institution of Mechanical Engineers, recommends half an inch clearance between the wheels of a railway coach and the brake blocks, and it is usual in railway practice to place the blocks level with the wheel centres, or somewhat higher. The nice adjustment of control needed for working hand brakes efficiently, especially when rails are greasy, and therefore easily skidded, is hardly possible with brake rigging such as was used. The transmission was by a chain wound upon a spindle and through a series of rods and levers, "often roughly shaped to size and length in a forge, and connected by ill-fitting pins and joints, or by short lengths of chain," as the Board of Trade report states. It is easy to understand that lost motion, due to such rigging, would account for a good deal of lag even if the gear were new.

AN EDUCATIONAL GAP.[1]

FOR many years past the attention of those who have been giving serious consideration to the complex educational problems which arise in this country has been directed to the gap which exists between the time at which pupils ordinarily leave the public elementary schools and that at which a very small proportion of them appear as students at our technical institutions and at various evening classes. Many attempts have been made to bridge over this gap by continuation classes of various kinds and under various conditions, but these attempts cannot be said to have been successful in the past to any extent commensurate either with the importance of the problem or with the amount of care which has been bestowed upon it. The causes of failure are deeply rooted in our social and economic organisation, whether we consider the large towns, the country districts, or the intermediate districts which are partly urban and partly rural. In the large towns, for instance, as soon as a lad is released from compulsory attendance at school, either by age or by the attainment of the necessary standard, his services have a market value which his parents are usually very unwilling to forego, though its immediate sacrifice may have an important effect upon the ultimate success of the youth in after life. The consequence is that, especially in London, large numbers of these boys take positions as van boys, errand boys, and in similar occupations, in which for a few years they can earn wages up to or exceeding 10s. per week. By the time, however, that they reach the age of eighteen or nineteen they cease to be eligible for such work, and, not having utilised the intervening years since leaving school in attaining expertness in any skilled occupation, there is no other course open to them but to join the ranks of unskilled labour, whence the step to those of the unemployed and unemployable is easy, especially as they have reached the age at which their parents can no longer be expected to contribute to their maintenance. In the country, other causes lead to somewhat similar final results.

The inquiry of the consultative committee deals in great detail with one series of suggestions and experiments for bridging this gap for a minority of the pupils referred to. The particular problem minutely examined is that of providing slightly "extended facilities" (in a secular sense) for the best pupils, who would otherwise leave the elementary schools at the usual age of fourteen years or earlier, and whose parents would be subjected to the temptations mentioned above. The question inquired into is how best to establish a type of school capable of educating such children, the parents being willing to maintain them for the necessary time, to a somewhat higher standard without trenching on the proper province of the secondary schools, on the one hand, or of the training which prepares specifically for a definite career on the other.

The problem is one well suited for the consideration of the consultative committee on account of the wide and varied educational experience of its different members. To strengthen its hands, and to obtain the necessary information which might not be available within the four corners of its own membership, it has examined a carefully selected number of representative official and non-official witnesses, twenty-five in all. For obvious reasons the names of the official witnesses are withheld, and therefore no names whatever are given; nor is the evidence published in full, but ample quotations are made from it wherever they are deemed necessary and relevant to support the arguments of the report. The only criticism one has to make upon the selection of the witnesses is that so few as five employers of labour can scarcely have had sufficiently varied individual experience to supply materials for dealing with so large a problem.

That the present is a time of transition and experiment, and that the points of view from which educational problems are being attacked are rapidly changing, could receive no greater exemplification than is conveyed by this report. The gradual change of the official attitude towards such problems has been very apparent to outside observers during the last four or five years in the different reports, prefatory notes to codes, and other official publications issued by the Board of Education from time to time. This report deals in full detail with numerous points brought into view by the new standpoints, and it is to be hoped that the conclusions of the committee on these and cognate matters may be fully adopted by the Board in shaping its policy, without, however, rushing into opposite extremes.

The swing of the pendulum from the time when "payment by results" was the fashionable official system has indeed been great, and every page of this report bears evidence of the distance which has been travelled from those "dark ages." In point of time, however, the period referred to is sufficiently close to have left a legacy, which forms a factor in the present problem, in the shape of a body of teachers some of whom still find it difficult to realise that they are "freed from the trammels they have been accustomed to all their lives," and who have "a certain stock-in-trade which they think can be used anywhere."

The chief value of the report consists in the recognition, and some of the consequences of that recognition, of the proper function of education, in the root sense of the word, as a training of the moral qualities, the formation of habits of mind being regarded as more important than the acquirement of mere knowledge. Prominence is given to the importance of the development of self-activity and resource and powers of observation, the fostering of intelligence and interest in the work, and that training of the eye and the hand in conjunction with the brain which leads to "general handiness." These are some of the points dwelt upon, not once or twice, but many times and in varied aspects, in the pages of the report.

The report also puts its finger upon some of the most glaring defects of the present and previous systems of education, both elementary and secondary. The results, which have long been painfully evident to those who in any form have been entrusted with the further education of the pupils turned out, are that these pupils have not

[1] Report of the Consultative Committee upon Questions affecting Higher Elementary Schools. (Adopted by the Committee May 24, 1906, and issued, with a Prefatory Note, by the Board of Education, July 20, 1906.)