chanism, especially in "parallel motions," both real and approximate.

The familiar theorem that *the relative velocities of points in any body vary as their instantaneous radii* needs merely to be mentioned. It is to be regretted that it is not more generally used, for while it does not increase the difficulty of comprehending simple cases, it is of enormous advantage in simplifying such (apparently) complex ones as not unfrequently occur in mechanism.

The expression for static equilibrium is also tolerably familiar :—*the sum of the moments of all the forces acting upon a body about its inst. centre must* = 0. For practical purposes, however, it is generally more convenient to state the proposition :—*the resultant of all the forces acting upon a body must pass through the point of contact of its centroids.* The application of this proposition to all the simpler cases is self-evident, and at the same time it reduces complex cases to their smallest possible dimensions, rendering most very easy, and in many cases greatly aiding the comprehension of the alterations in conditions of equilibrium corresponding to consecutive alterations in the positions of mechanisms as their links move. It may just be noted that as the two forces of a couple have for their resultant a force (infinitely small) acting along the line at infinity, the proposition gives at once that where the inst. centre of a body is at infinity it is in equilibrio under any number of couples of any magnitude. In the case of a body moving parallel to itself, therefore (see *ante*) all couples may be neglected so far as its static equilibrium is concerned, whatever their magnitude or sense.

The following are, in conclusion, a few of the kinetic propositions the solution of which is greatly aided by the use of centroids :—

(I.) If a force[1] constant in direction and position act upon a body, then (i.) if it cut the centroid for the motion of the body in one or more points motion will take place until the first of these becomes the point of contact, and will then cease; (ii.) if it pass entirely without this centroid, there will be continuous motion. As corollaries to (i) may be mentioned (*a*), if the centroid for the motion of a body be a curve of the 2nd, 3rd . . . *n*th order, the body has a maximum of 2, 3 . . . *n* positions of equilibrium under some one or more forces constant in direction and position. Also (*b*), if a body have not more than a single position of equilibrium under any such force, the centroid for its motion must be a straight line.

(II.) If the position of a force relatively to the body upon which it acts remain constant, then (i.) if it cut the centroid of the body in one or more points, motion will take place until one of these becomes the point of contact, (ii.) if it lie entirely without the centroid of the body, there will be continuous motion. This gives corollaries as to positions of equilibrium similar to those just stated.

(III.) If a force constant in direction act always at the same point of a body, motion will continue until the instantaneous radius of the point becomes parallel to the direction of the force. There is here no case of continual motion; the theorems as to number, &c., of positions of equilibrium are similar to those given above.

English writers have used these curves very little. Among modern continental writers who have employed them may be mentioned Dwelshauvers-Dery (Liège) who uses them in his "Cinématique" for questions relating to relative velocities; Schell (Carlsruhe) in his "Theorie der Bewegung u. d. Kräfte; Reuleaux ("Theoretische Kinematik," and elsewhere), who gave them the name (*Polbahnen*), by which they are known in Germany, and who has used them ably and extensively for kinematic problems; and lastly Pröll, who has made use of them in his recent "Versuch einer graphischen Dynamik." The writer has not, however, found them anywhere unreservedly adopted, and has, therefore, made this attempt to show how easily centroidal methods adapt themselves to the general treatment of mechanical problems, especially those connected with mechanism, and at the same time how well suited they appear to be for educational purposes.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1882, MAY 17.—Hallaschka, in his "Elementa Eclipsium," describes this eclipse as broadly total, whereas, it will be, in reality, total, though the zone of totality will not be a broad one. An error in the moon's semi-diameter led to the statement in Hallaschka's work. The following elements of this eclipse, calculated upon the same system that has been applied in the examination of other solar eclipses in this column, will probably be near the truth :—

Conjunction in R.A., May 16, at 19h. 41m. 11·7s. G.M.T.

	° ′ ″
R.A.	53 56 35·4
Moon's hourly motion in R.A. ...	36 14·5
Sun's ,, ,, ,, ...	2 28·7
Moon's declination	19 38 46·4 N.
Sun's ,, ...	19 19 38·8 N.
Moon's hourly motion in decl. ...	4 56·0 N.
Sun's ,, ,, ,, ...	0 33·8 N.
Moon's horizontal parallax	58 15·1
Sun's ,, ,, ...	8·8
Moon's true semi-diameter	15 52·4
Sun's ,, ,, ...	15 48·8

The central and total eclipse begins at 17h. 53·8m. in longitude 3° 11′ W., and latitude 10° 40′ N.; it occurs with the sun on the meridian in 63° 44′ E., and 38° 35′ N., and ends at 21h. 18·8m. in 138° 51′ E., and 25° 25′ N. The following are points upon the central line in that portion of its track where observations are most likely to be made :—

Long.	Lat.	Sun's Zenith dist.	Long.	Lat.	Sun's Zenith dist.
° ′	° ′	°	° ′	° ′	°
29 49 E.	25 36 N.	49·9	51 27 E.	35 30 N.	23·7
34 5	27 48	44·1	54 58	36 38	21·2
36 3	28 47	41·5	68 48	39 31	21·2
41 33	31 27	34·4	77 23 E.	40 2 N.	26·7
48 20 E.	34 21 N.	26·7			

The central line therefore commences in the west of Africa, and traversing that continent in the direction of Upper Egypt, it passes over the Nile below Thebes, thence over the extremity of the peninsula of Sinai, near Ras Muhammed, and almost directly over Hillah, the site of the ruins of Babylon, to Teheran. The position of this capital according to Gen. Stebitzky (*Astron. Nach.*, No. 2,113) is in longitude 3h. 25m. 41·7s. E. of Greenwich, and latitude 35° 41′ 7″, this point referring to the station of the Indo-European telegraph; so that the central line of shadow according to our elements passes sixteen miles to the south of it. Calculating directly for this longitude we have the following results :—

	h. m. s.	
Totality begins May 16 at	22 36 29	local M.T.
,, ends ,,	22 38 13	local M.T.
Duration	1 44	

The sun at an altitude of 67°. So that the greatest duration of totality in this eclipse about 12° east of Teheran is about 1m. 46s.

The central line subsequently traverses China, passing off at or close to Shanghai, at which place a total eclipse of short duration may be observed.

The next total solar eclipse on July 29, 1878, which crosses the United States is pretty fully noticed in the various Ephemerides, though in due time the American astronomers will no doubt provide a chart showing on a larger scale the breadth and position of the zone of totality over their country. Then follows the total eclipse of January 11, 1880, in which the track of the central line lies almost wholly upon the Pacific, the total phase being visible for a brief duration only near the coast of California, above San Francisco. The total eclipse of May, 1882, of which the elements are here given is the next in order of date.

THE COMETS OF 1402.—It is singular, considering the attention which the Chinese paid to the observation of comets, their annals containing reference to several hundreds of these bodies, should not have recorded the appearance of the two evidently great comets of 1402. In particular is this the case with the first comet, which, according to the descriptions in the European

[1] Or here, and in the following propositions, the resultant of any number of forces.

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chronicles collected by Pingré, was first seen early in February, and increasing daily in brilliancy, would appear, if we may rely upon the historians, to have presented a wonderful aspect shortly before Easter. On Palm Sunday, and two following days, we are told "its increase was prodigious;" "le dimanche, sa queue fut longue de vingt-cinq brasses; le lundi, de cinquante et même de cent; de plus de deux cents le mardi." It then ceased to be visible at night, but during the eight following days it was seen near the sun, which it preceded; its tail had then shortened to "une ou deux brasses," but its brilliancy was such that the light of the sun did not prevent its being seen at noon-day. It continued visible till the middle of April.

Some years since the late Mr. John Williams, Assistant-Secretary of the Royal Astronomical Society, and author of the valuable work upon Chinese cometary astronomy, at the request of the writer, made a strict search for mention of a comet or comets in 1402 in several Chinese authorities in his possession, but without any success; nor is there any reference to a comet in this year in M. Biot's translations. Failing thus to obtain any data for calculation beyond the vague indications of the comet's positions given in the "Cometographie," the writer endeavoured to utilise them to form some idea of the orbit, and found that with perihelion passage assumed on March 21, in longitude 208°, ascending node 117°, inclination 55°, least distance 0·38, and direct motion, the principal circumstances of the comet's appearance, so far at least as regards track across the heavens, might be represented; but its extraordinary brightness is not easily accounted for. The comet is mentioned in Kaempfer's History of Japan, which renders it the more curious that the Chinese annals should have no account of it. Struyck thought it was a return of the comet of 1661, but in his day that body was thought to be identical with Apian's comet of 1532, an idea which was negatived by Mechain's subsequent calculations and by the non-discovery of the comet about the year 1790, notwithstanding Maskelyne's efforts to insure observations if it returned at that time.

METEOROLOGICAL NOTES

Variations in the Relation of the Barometric Gradient to the Force of the Wind.—In a very suggestive paper recently communicated to the Meteorological Society of London, Mr. Clement Ley shows that the mean velocity of the wind corresponding to each barometric gradient is much higher in summer than in winter, and that this is the case at all stations examined, with all winds, with all lengths of radius of isobaric curvature, and with all values of actual barometric pressure. The diurnal and seasonal variation in the relation of the gradient to the force of the wind is unquestionably one of the fundamental questions of meteorological research, and we hope Mr. Ley will soon again return to its discussion, with ampler data for a more satisfactory handling of the subject than he has yet had before him. That the mean diurnal oscillations of the barometer cannot be neglected in the inquiry is very evident. Thus, while in June at 8 A.M. the barometer at Kew is 0·015 inch above the daily average, on the coast at Falmouth it is only 0·001 inch; but while at 3 P.M. it is 0·015 inch below the average at Kew, it is still 0·001 inch above the average at Falmouth. Crossing to the Continent and contrasting Helder on the coast with Namur inland, it is seen that in June at 8 A.M. the barometer at Helder is 0·004 inch under the average, while at Namur it is 0·008 inch above it, but at 3 P.M. it is at Helder 0·007 inch above, whereas at Namur it is 0·011 inch below the average. An interesting part of the paper is that descriptive of the mean diurnal variations in the velocity of the wind, in which, among other interesting features, it is pointed out that at the coast stations, the mean horary curve in summer approximates in type to the winter curve at the inland stations, the diurnal maximum being about 2 P.M. In connection with this it is interesting to note that while at Valentia and Falmouth the anemometric maximum occurs in summer about 2 P.M., the barometric minimum does not occur till from three to four hours later. The point might be even still more strikingly put by a reference to the observations made at Pola, near the head of the Adriatic Sea, where during June, July, and August, 1876, the anemometric maximum occurred from 10 A.M. to noon, and the barometric maximum from 11 A.M. to 1 P.M. The two maxima are thus all but contemporaneous, a result directly opposed to the view generally entertained that in such cases the barometric maxima are contemporaneous with the anemometric minima. London presents very considerable facilities for the working out of this question in its two well-equipped observatories at Greenwich and Kew, and in the number of meteorological stations situated within a radius of fifty miles, in connection with the Meteorological Office, Mr. Glaisher, and the London Meteorological Society. Observations made at these stations at 9 A.M., 3, and 9 P.M., would render possible the drawing of the isobarics over the south-east of England, with an approach to correctness sufficient to give the barometric gradients for Greenwich and Kew as may meet the requirements of the problem. Isobarics drawn from the Daily Telegraphic Reports alone, while sufficient in a first tentative inquiry, are, owing to the great distances between the stations, necessarily very hypothetical, and therefore much too rough for any satisfactory investigation of this important subject.

Climate of Pekin.—A memoir on this subject, read by H. Fritsche before the Imperial Academy of Sciences of St. Petersburg on August 17, 1876, has just been published in the *Repertorium für Meteorologie*. The memoir is an able and exhaustive discussion of the elaborate meteorological observations made at Pekin from the beginning of 1841, and published by the Russian Government under the superintendence successively of Kuppfer, Kaemtz, and Wild. H. Fritsche has thus been able to give in a very complete form the hourly and general monthly averages for temperature, pressure, and humidity, and very satisfactory, though necessarily less complete, averages of wind, cloud, rain, snow, hail, and thunderstorms. The mean temperature and pressure of each day of the year has been worked out in detail, and several of the more important extremes are also tabulated. This well-discussed material has a peculiar meteorological value, arising from the position of Pekin with reference to the continent of Asia, since it results from that position that Pekin may be regarded as situated during the winter months in an extensive anti-cyclone, the prevailing winds being from the continent seawards, and from at least April to July, in an extensive cyclone when the prevailing winds blow from the sea in upon the continent. Hence its dry winter climate, the mean monthly rainfall amounting only to 0·14 inch, and its wet summer climate, the average rainfall in July being nearly 20·00 inches. Hence also snow falls only on eleven days during the year. Thunderstorms occur on twenty-seven days, from the end of April to the beginning of October, reaching the maximum in June, July, and August, when a thunderstorm occurs on an average about every fifth day. The same season marks the period of hail, which is, however, of rare occurrence, being only once in two years. Of special interest are the hourly averages in their relation to the winds and weather of this part of Asia. Thus, while the climate of Pekin loses much of its continental character during the summer months, the hourly barometric curves lose their strictly continental character, the morning minimum, for instance, falling close to, or even slightly below, the mean of the day, thus tending to be assimilated to the curves of the sea-side climates about the latitude of Pekin.

Why the Barometer does not always Indicate Real Vertical Pressure.—Mr. Robert Tennent writes from Edin-

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