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W. J. C. MILLER

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FROM THE "EDUCATIONAL TIMES,"

WITH MANY ADDITIONAL

PAPERS AND SOLUTIONS

NOT PUBLISHED IN THE "EDUCATIONAL TIMES."

AND

AN APPENDIX.

EDITED BY

W. J. C. MILLER, B.A.,

REGISTRAR
OF THE
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1192. (The Editor.)—In order to ascertain the heights of two balloons (Q, M), their angles of elevation as set forth hereunder are observed, at the same instant, from three stations (A, B, C) on the horizontal plane, whose distances apart are AB = 553, BC = 791, CA = 399 yards, (Q, A) denoting the elevation of Q at A, &c.:—

(Q, A) = 84° 10′ 10″	(M, A) = 84° 2′ 50″
(Q, B) = 76° 13′ 46·5″	(M, B) = 75° 57′ 1″
(Q, C) = 79° 35′ 6·5″	(M, C) = 79° 22′ 12″

It is also observed that only *one* of the balloons (Q) is vertically over the triangle ABC. Show that the heights of the balloons Q, M are 1874·8, 3339·4, and that their distance apart is 1560·4 75

1208. (The Editor.)—Show that the values of x, y, z, from the equations

$x^2+4xy+6y^2=28,\ x^2+4xz+14z^2=60,\ 3y^2+2yz+7z^2=40$ ...(1, 2, 3),

are given by

$$x^2 = (\pm\sqrt{5}-1)(\pm 5\sqrt{2}-6)(\pm\sqrt{10}-2),$$
$$y^2 = \tfrac{1}{2}(\pm\sqrt{5}+1)(\pm 5\sqrt{2}-6)(\pm\sqrt{10}+2),$$
$$z^2 = \tfrac{1}{12}(\pm\sqrt{5}+1)(\pm 5\sqrt{2}+6)(\pm\sqrt{10}-2).$$ 122

1966. (The late Samuel Bills.)—Find values of x, y that will make $S \equiv (p^2+q^2)^4 + 64\,p^2q^2(p^2-q^2)^2$ a perfect square 80

3826. (J. B. Sanders.)—The heights of the ridge and eaves of a house are 40 feet and 32 feet respectively, and the roof is inclined at 30° to the horizon. Find where a sphere rolling down the roof from the ridge will strike the ground, and also the time of descent from the eaves......116

2x

4038. (Rev. T. P. Kirkman, M.A., F.R.S.)—Prove that (1) a triangle can be partitioned into 13 triangles in 457 ways, two ways being reckoned the same if one is in any position the reflected image of the other, the size of the partitions being of no consequence; and find (2) in how many ways an equilateral triangle can be partitioned into 13 triangles of equal area. 108

4165. (J. Conwill.)—A fish is floating in a cubical glass tank filled with water, with its head in one corner, and its tail towards the one diagonally opposite; describe the appearance which will be presented to an eye looking towards the corner in the direction of the length of the fish, and in the same horizontal plane with it. 117

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4737. (Professor Artemas Martin, M.A., Ph.D.) — Three equal circles, each 4 inches in diameter, are drawn at random on a circular slate whose diameter is 12 inches; find the probability that each circle intersects the other two 118

5200. (S. Tebay, B.A.)—A small marble is thrown at random on a square table having an elevated rim. If it be struck at random in any direction, determine the probability that it impinges (1) on two opposite sides; (2) on two adjacent sides, and one opposite; (3) on three consecutive sides; (4) on the four sides in succession. 91

5218. (The Editor.)—A circular target revolves uniformly around a vertical axis, lying in its plane and passing through its centre; and a shot is fired at the target in (1) a given or (2) a random direction: find, in the first case, the chance that the shot will hit the target, and show therefrom that, in the second case, the chance is $2/\pi$. 109

5481. (Professor Burnside, M.A.)—Trace the relation between the characteristics of a curve of the mth degree having the maximum number of double points, and the curve enveloped by the line

$$(a_0, a_1, a_2, \ldots a_m)(\theta, 1)^m = 0,$$

where $a_0, a_1, a_2, \ldots a_m$ are linear functions of the coordinates, and θ a variable parameter. 63

5501. (Professor Ball, LL.D., F.R.S.)—If in an equation x be changed into $k + x'^{-1}$, show that any semi-invariant of the transformed will be a covariant in k of the original equation. 67

5635. (Elizabeth Blackwood.)—Two excursion trains, each m yards in length, may start with equal probability from their respective stations at any time between 2 o'clock and 10 minutes past 2, in directions at right angles to each other, each at a uniform rate v; find the chances of a collision, each being n yards distant from the point at which their lines cross, and both being ignorant of the risk they are running. 36

5636. (C. Leudesdorf, M.A.)—A polished uniform straight metal rod is held in a horizontal position with one end fixed at a point A, and is then allowed to swing under the action of gravity till it reaches a vertical position, when the end A is loosed, and the rod allowed to fall; find the locus traced out by the image of the fixed point A, as seen from any point by reflection at the rod during the motion of the latter. 51

5672. (Col. Clarke, C.B., F.R.S.) — P and Q are two points in a finite line AB. The parts PA, QB are rotated in opposite directions round P and Q respectively, until A and B meet in a point R. Supposing P and Q evenly distributed, determine the law of density of the point R. 45

6118. (Professor Sylvester, F.R.S.)—A plane or solid reticulation, rigid but without weight, is formed by the intersections of equi-distant lines or planes. One of these intersections is fixed, and at a certain number of others of them, which are given, forces may be applied. It is obvious that there are an infinite number of sets of parallel forces each containing an exact number of pound weights, which, acting at the given points of application, will balance about the fixed point.

It is required to prove that out of these a *limited* number may be selected such that by their due repetition and superposition any other balancing set whatever may be formed. In other words, i balancing sets of parallel forces P, Q ... W (i being some finite number) may be found such that any other balancing set will be made up of m_1 of the first set or its opposite, m_2 of the second set or its opposite, ... m_i of the i^{th} set or its opposite; $m_1, m_2, \ldots m_i$ being positive integers.......................... 61

6218. (Professor Sylvester, F.R.S.)—If E_i denote

$$a_0 \frac{d}{da_i} + i a_1 \frac{d}{da_{i+1}} + \frac{i(i+1)}{1 \cdot 2} a_2 \frac{d}{da_{i+2}} + \&c.,$$

and F_i denote $a_0 \frac{d}{da_i} + (i+1) a_1 \frac{d}{da_{i+1}} + \frac{(i+1)(i+2)}{1 \cdot 2} a_2 \frac{d}{da_{i+2}} + \&c.$;

(1) express $(F_1)^n$ in terms F_1, F_2, F_3, &c.; and (2) I being an invariant of the i^{th} order of $(a_0, a_1, a_2 \ldots a_n)(x, y)^n$, which becomes I′ when every suffix is increased by unity, show that $I = \phi I'$, where

$$\phi = \Sigma \frac{E_r^{\lambda} \cdot E_s^{\mu} \cdot E_t^{\nu} \ldots}{\lambda ! \, \mu ! \, \nu ! \ldots},$$

and $\lambda, \mu, \nu \ldots r, s, \ldots$ are any integers satisfying the equation

$$\lambda r + \mu s + \nu t + \ldots = i. \quad \ldots\ldots\ldots\ldots \quad 30$$

6251. (The Editor.) — One of the diagonals of a regular quindecagon is drawn at random, and then the process is repeated; show that (1) the probability of the chosen diagonals being such as cross within the perimeter is $\frac{91}{534}$ if the two must be distinct, and $\frac{91}{540}$ if the second may be identical with the first; (2) the like probabilities for a regular $(2n+1)$-gon are $\frac{1}{6}(2n^2-n)$ divided, in the two cases respectively, by $[(2n+1)(n-1)-1]$ or $[(2n+1)(n-1)]$; and hence (3) the chance of two random chords meeting within a circle is [illegible] or $\frac{1}{3}$... 23

6418. (Professor Malet, M.A., F.R.S.) — Prove the following extension to surfaces of Chasles' theorem for plane curves:—If to a surface of the class n any system of n parallel tangent planes be drawn, then the centre of mean position of their points of contact is fixed.................. 60

6456. (G. Heppel, M.A.) — If the expansion of $\sec x$ be $1 + \frac{u_2}{2!} x^2 + \frac{u_4}{4!} x^4 + \&c.$, and that of $2 \sec^3 x$ be $2 + \frac{v_2}{2!} x^2 + \frac{v_4}{4!} x^4 + \&c.$; prove