A REASONING HORSE.

Hardly a day passes but the newspapers have something to say of the wonderful mental performances of "clever Hans," "*der kluge Hans*," as Herr Von Osten's stallion is called. Indeed, some wordy controversies have been waged over him. Some hold that he actually reasons; others skeptically assert that his intelligence is simply the result of ingeniously concealed trickery on the part of his trainers. An investigation conducted by scientists, however, would seem to indicate that the horse is really what his owner claims him to be, an intelligent four-footed animal, capable of making simple arithmetical calculations, and even of ratiocination. Dr. Heinroth, of the Berlin Zoological Garden, has this to say of Hans' wonderful feats in a recent number of the Illustrirte Zeitung:

"For many years Herr Von Osten, who was at one time a tutor of mathematics, has made it his task to determine the intellectual possibilities of a horse. His first stallion, with whom he succeeded in doing remarkable things, died at the end of eight years. Hans, his second acquisition, has been under his care for four years. Von Osten has no desire to sell the horse or to display him for money in public. He is instructing him in the interest of science alone.

"In my presence Von Osten asked the horse to add such sums as 6 + 2 and 4 + 3. The horse indicated the correct answers by stamping with his right fore-hoof. It is to be remarked that during the calculations Von Osten feeds Hans with carrots. Von Osten declares that without the carrots the horse would refuse to work. Hans has never felt the touch of a whip. This, after all, is not very strange; for, as Von Osten puts it, carrots are to Hans simply what honors, titles, rank, and money are to men.

"I asked 'What are the multiples of 12?' The answer came almost immediately. Sums such as 72 + 14 are correctly given. The actual words (in German) 'What is the difference between 43 and 6?' were read, and the answer immediately pawed. No numerals appeared on the blackboard. Surely, this is more than the trickery of training. It should here be mentioned that questions can be put by any by-stander. Hans is able to convert common fractions into decimal fractions. He can also tell time by the clock. If he is asked, 'It is now 40 minutes after 12; how many minutes will elapse before one o'clock?' he immediately answers with twenty strokes of his hoof. These are simply a few among a great number of questions that were put.

"Hans knows the coin of the realm and the value of playing cards. King, queen, ace, and the like are differentiated by the hoof. He picked out a badly-worn German 50-pfennig piece from several coins. From a number of pieces of colored cloth laid upon the ground he will select any color he is ordered to choose. 'Is it green?' you ask. Five strokes of the hoof is the reply; and the fifth cloth proves to be green. The colors may be changed in any manner; still the horse will pick out the correct one."

Dr. Heinroth concludes his article by stating that he is quite convinced of the impossibility of any deception. He has questioned the horse in his stall in the absence of its owner, and he has received answers as clear cut and as precise as those given in the presence of Von Osten.

The Reasoning Horse "Hans" and His Owner.

"Hans" Answering an Arithmetical Question by Pawing With His Hoof.

A REASONING HORSE.

Some figures have been published on the production and commerce of quinine. According to the report of the chief of the government plantations in British India, the Madras government produced 15,711 pounds of quinine in 1902, and the Bengal government 11,927, making a total of 27,638 for India. Java produced and exported 43,750 pounds. As to the exportation of bark for 1902, Java heads the list with 14,726,000 pounds, followed by India with 2,020,000, Ceylon with 407,000, South America 775,000, and Africa 180,000, making a total of 18,108,000 pounds. This represents the bark which has been supplied to the trade, and it is estimated to contain 861,810 pounds of quinine. Adding these figures to the above-mentioned quantity produced in India and Java, we have a total of 933,200 pounds, which represents the total amount of quinine produced in 1902. As to the quinine-producing establishments, there are 5 in France, 3 in England, 2 each in Germany and Italy, one each in Holland, Java, Bengal, and Madras, besides those in America. The two leading markets are Amsterdam and London, but the latter has become less important since the development of the Java production.

WHEN WAS THE PHOTOGRAPH TAKEN?

BY PROF. WILLIAM F. RIGGE.

I wonder what the reader will say when I show him this photograph of the Creighton University Observatory [at Omaha, Neb.] and ask him to tell me when the photograph was taken. I will allow him every liberty but one—he must not ask the photographer.

The condition is rather severe, but not worse than my own, because I do not know the photographer, nor could I after diligent inquiry find anyone who knew anything at all about the picture.

I am very fond of mathematics. It seems to run in my blood. I looked upon this picture for years, and was convinced that the shadows in it had automatically and unmistakably stamped the date and time of its taking upon the photograph. I investigated, I measured, I computed. And now I know when the photograph was taken. If the reader is willing, I will take him into my confidence, and show him how the problem was solved. I will investigate three things: 1, whether it is possible in principle to obtain the date of a photograph from the shadows in it; 2, whether it is possible in practice; and 3, how closely our results are to be trusted.

The direction in which the shadow of an object is cast evidently depends upon the sun's position in the sky, and ought therefore to serve as a means to obtain this position. Now, the twofold motion of the sun is causing it continually to change its position: the diurnal motion is carrying it about in a circle whose center is at the celestial pole, the annual one is carrying it toward or away from the celestial equator. As these two motions are independent of one another, every determination of the sun's position by means of a shadow it casts ought to give us its place in both of these orbits, that is, give us the time of the day and the day of the year. Fig. 2 will show us how this is done.

Let us imagine the heavy line AB to be the shadow cast upon a horizontal surface by the vertical rod OB. With the radius AO let us describe a miniature celestial sphere about the point A as a center. Let $NESW$ be the great circle of the horizon with its cardinal points, and $NPZS$ that of the meridian. Z, vertically over A, will be the zenith, O will be the sun's position, and P, so taken that the angle NAP is equal to the latitude of the place, will be the celestial pole. The points Z, P, O—zenith, pole, sun—are the vertices of the great astronomical triangle with which we must become acquainted. The side PZ is the complement of the arc NP, which is equal to the latitude of the place. The side PO is the sun's polar distance, and is the complement of its declination, or of its distance from the celestial equator. The side ZO is the sun's zenith distance and the complement of its altitude OH or of the angle OAH. The angle at the pole, ZPO, is called the sun's hour angle, and is proportionate to the time elapsed since the sun crossed the meridian. The angle at Z, PZO, or its equal NAH, is the sun's azimuth, or bearing, as a surveyor would call it, reckoned from the north point of the horizon. The angle at O, POZ, is called the parallactic angle. We have no need of it in our discussion. In this triangle the hour angle ZPO determines the sun's position in its diurnal orbit and gives us the time of day; the side PO, the complement of the sun's declination, determines the sun's position in its annual orbit and gives us the day of the year. The measurement of the shadow AB of the rod OB must, therefore, in some way give us the angle ZPO and the side PO. It does so indirectly. Spherical trigonometry teaches us that if any three of the six parts (three sides and three an-

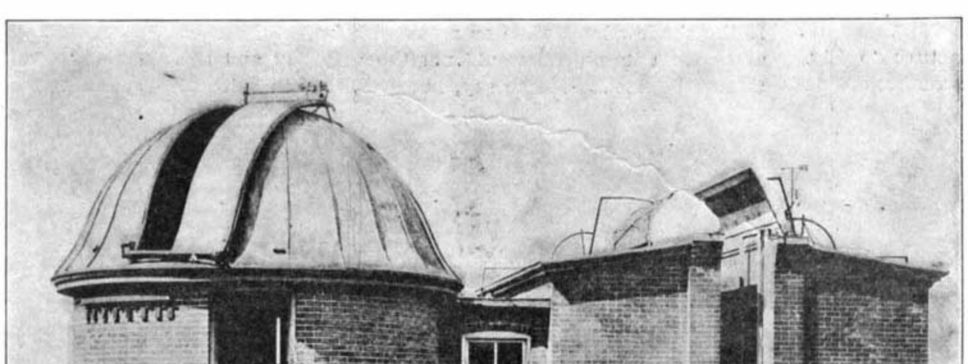

Fig. 1.—WHEN WAS THIS PICTURE TAKEN?