## Astronomical Notes.

### How Far to the Nearest Star.

A correspondent says: "I read the following in a magazine the other day: 'There is a train that travels from London to York every day at the rate of fifty miles an hour. If that train ran from York to the sun, and never stopped, day or night, it would take over two hundred years to get there! But suppose it travelled on from the sun to the nearest star, it would have to rush on at the rate of fifty miles an hour for more than forty-six million years before it would reach the star? I wish you would tell us in the Review something about this, especially how one might work out such a sum for one's self.'"

The nearest star is Alpha Centauri. It is a first magnitude star in the right foot of the Centauri. It is the third brightest star in the heavens — only Sirius and Canopus being brighter—but it is too far south to be seen from this latitude. My correspondent wants to know how he might work out for himself the problem of finding how many years it would take a train, travelling continuously at the rate of fifty miles an hour, to pass from the sun to Alpha Centauri.

Let us assume, firstly, that we know the size of this earth of ours. We certainly do know it very exactly. I shall call its equatrial semi-diameter.

Assume, secondly, that we know the sun's parallax —the value of it, I mean. As to what this thing called "parallax" is, and how its value is found, I must refer you to the astronomy books. This is no place for enlarging on that subject. But if you will be good enough to imagine the axis of the earth to be sticking out for a hundred millions of miles or so beyond the north pole; and imagine the sun, at his mean distance, to be stuck on this produced axis like an orange on a darning-needle; and then imagine that the sun, so placed, there is a sea-captain testing his sextant for index-error—if you will do these things well you will lay a foundation for a clear conception of what the thing is that is called the sun's parallax. When a sea-captain tests his sextant for index-error on the earth, he measures the sun's diameter and finds it to be—not so many inches or feet or miles, but—so many degrees of minutes or seconds—not far from thirty-two minutes it is generally found to be. Let us suppose our Solar Salt to do the same thing with the earth. He measures the angular diameter of the earth as seen from the sun. He writes the result on paper and divides by two. This is the angular measure of the earth's equatorial semi-diameter as seen from the sun when he is at his mean distance from the earth. This is the thing that is called the sun's parallax. In this art.cle I shall call it S.

It ought to be clear from what has been said that S can't be measured directly by anybody on the earth. But other small angles can be measured that are related to it, and from their measured values its value can be calculated. And from its value we can calculate the distance of the sun from the earth. This is only a problem in right-angled trigonometry. Call the distance R. This is the hypotenuse of a right-angled triangle, of which r (see above) is the perpendicular, and S is the angle between R and the bars. So we have

$$R = \frac{r}{\text{Sin. } S} = \frac{r}{S \text{ Sin. } 1''} \quad \text{because S is very small.}$$

If you prefer it, you may take away Sin. 1″ from the denominator, and multiply the numerator by 206265 instead. To get R in miles, take the best values you can find in the astronomy books for r and s and work out the result for yourselves. For r use miles, for S use what you find which will be seconds.

Now for our star. Its distance, like the sun's, is got from its parallax. To find the sun's parallax is a very delicate job, but to find that of a star is a bit of celestial land-surveying far more delicate still. "The operation," says Prof. Young, of Princeton, "is, on the whole, the most delicate in the whole range of practical astronomy." In the case of the sun, the earth's radius is used as a base-line, and yet the angle subtended by this length of 4,000 miles is less than 9 seconds of arc, that is, less than the 200th part of the apparent diameter of the full moon. In the case of a star, the base line is the distance from earth to sun—a distance more than 23,000 times 4,000 miles—but, even so, the parallax is much less than that of the sun. Let us suppose it measured. We have now to find the star's distance D, knowing the base-line R and the parallax p.

Just as in the previous case we have

$$D = \frac{R}{\text{Sin. } p} = \frac{R}{p \text{ Sin. } 1''} \quad \text{because p is very small.}$$

$$\text{And as } R = \frac{r}{S \text{ Sin. } 1''}, \text{ it follows that}$$

$$D = \frac{r}{p\, s \text{ Sin.}^2\, 1''} = \text{number of miles in star's distance.}$$

Now if we put v for the train's velocity per hour h for the number of hours in a year, and y for the number of years we want, we shall have, by ordinary arithmetical analysis,

$$y = \frac{D}{v\, h} = \frac{r}{v\, h\, p\, s \text{ Sin.}^2\, 1''} = \text{number of years required.}$$