important work, *On conoidal and spheroidal figures* (*Περὶ κωνοειδέων καὶ σφαιροειδέων*), which among other things discussed the problem, already famous, of 'squaring the circle'. A little work which has not come down to us in its original form attacked the same problem from another angle, and evaluated π within fairly close limits; yet another, now lost, calculated it still more closely.[14] This and other questions which interested him involved finding a better system of numeration than that generally in use among Greeks;[15] from this sprung a popular essay, addressed to Gelon, son of Hieron II of Syracuse, known as *The Sand-reckoner* (*Ψαμμίτης*), showing that it was perfectly possible to reckon the number of grains of sand required to fill the whole universe, by employing an ingenious system of his own for expressing high figures, and therefore that the common proverb 'numberless as the sands' was wrong.[16] For Archimedes was capable of joking, provided the joke was mathematical; he seems to have liked puzzles, since there survive fragments of a work on the theory of the *stomachion* ('teaser'), a sort of tangram, whose fourteen pieces can be put together into a square and also into figures of various sorts;[17] he is also alleged to be the author of an epigram inviting the reader to calculate the number of the cattle of the Sun (cf. p. 27) from data the working out of which involves handling numbers which run into many millions.[18] In more serious mood he wrote a work *On Spirals* (*Περὶ ἑλίκων*), another on equilibrium (*Περὶ ἰσορροπιῶν*), in other words on statics, yet another, preserved complete in a Latin translation of 1543 from a MS. now lost, partly in a palimpsest discovered by Heiberg, on hydrostatics (*Περὶ ὀχουμένων*, literally *On things carried*, *sc.*, on water or other fluid, *i.e.*, floating). Other works are preserved in fragments, or not at all.

[14] For particulars, see Heiberg, p. 26.

[15] There is no name in ordinary Greek usage for a larger number than 10,000, and figures were expressed by letters of the alphabet in a manner far less convenient than our Arabic numerals.

[16] The difference between infinity and a very large finite number is by no means clear to the non-mathematical; Horace (*Odes*, i, 38, 1) makes Archytas 'measure the unnumbered sands', perhaps confusing him with Archimedes, and Apollo expresses his own omniscience by declaring that he knows 'the number of the sands and the measures of the sea', Herodotos, i, 47, 3. Cf. Pindar, *Ol.* ii, 98.

[17] Good account, with diagram, by R. D. Oldham in *Nature*, 1926, p. 337. Text in vol. ii, pp. 416–24, of Heiberg's ed. of Archimedes, (Teubner). Cf. Ausonius, *Cento nuptialis*, in the prefatory letter (vol. i, p. 374 of the Loeb ed., where correct the corrupt *ostomachium* of MSS. and editors).

[18] Vol. ii, p. 528 *sqq.*; Heiberg. It is called *πρόβλημα βοεικόν*.

After the great age, mathematics continued to be studied, even to make advances here and there, for several centuries. ZENODOROS is of uncertain date; we have a work of his *On Figures of equal Perimeter* (*Περὶ ἰσοπεριμέτρων σχημάτων*). Out of several works dealing with spherical trigonometry we have an Arabic version of one, the *Sphaerica* of MENELAOS of Alexandria, who lived in the first century A.D. The discovery of a MS. at Constantinople [19] has given us a writing of HERON, *On Mensuration* (*Μετρικά*); he also commented on Euclid's *Elements*. NIKOMACHOS, a Neo-Pythagorean of about the second century A.D., wrote an *Introduction to Arithmetic* (*Ἀριθμητικὴ εἰσαγωγή*) which we still have, and a work on *Arithmetical Theology* (*Ἀριθμητικὰ θεολογούμενα*), *i.e.*, on the mystic meanings given by Pythagoreanism to the first ten numbers, of which we have an abstract and some fragments. A better author, though later (third century A.D.), is DIOPHANTOS of Alexandria, of whose thirteen books on arithmetic (*Ἀριθμητικά*) six survive; their contents include a good deal of what we now call algebra. PAPPOS, also of the third century, was a very respectable mathematician, widely read in the classical works of Archimedes and the rest; hence his *Collection* (*Συναγωγή*) of comments on and supplements to their writings, with historical notes and other welcome information, is of much use to students of the history of the subject, besides presenting a picture of what mathematical studies were like at that date. After Pappos comes a long line of commentators, reaching to the Revival of Letters and leading up to the modern renaissance and progress of the subject.

Mathematical knowledge was required, then as now, for any serious work on ASTRONOMY. This was ardently studied at Alexandria, and great progress made, which might have been greater if ARISTARCHOS of Samos had succeeded in convincing the world that the sun and not the earth is the centre of our system.[20] Unhappily for the progress of science, his theory was rejected, partly on theological grounds; his works are lost, save for a little treatise *On the sizes and distances of the Sun and Moon* (*Περὶ μεγεθῶν καὶ ἀποστημάτων ἡλίου καὶ σελήνης*), and his only known follower was the rather obscure Seleukos, about 150 B.C., that is to say some 130 years later.[21] But most of the astro-

[19] First published in 1903 by H. Schöne, *Heronis opera*, iii (Teubner).

[20] Archimedes, *Ψαμμίτης*, i, 4 *sqq.*; Plutarch, *de facie in orbe lunae*, 923 a; Kleanthes the Stoic (see p. 360), declared, presumably in his work *Against Aristarchos*, Diog. Laert., vii, 174, that he ought to be prosecuted for impiety in 'disturbing the hearth of the universe', *i.e.*, the earth; Sextus Empiricus *Πρὸς δογματικούς*, iv, 174. Copernicus, when framing his hypothesis, was much comforted to find he had an ancient authority to support him.

[21] Plutarch, *Platon. quaest.*, 1006 c, who says S. gave a proof of the theory.