

4. If a straight line falling on two other straight lines makes the alternate angles equal to one another, then the straight lines are parallel; and, conversely, if these lines are parallel then the alternate angles are equal to one another.

5. Describe a parallelogram equal to a given rectilineal figure, and having an angle equal to a given angle.

6. On the diagonal AC produced of a square ABCD a point K is taken such that AK is double of AB; KF is drawn from K parallel to CD to meet AD produced in F. Show that the triangle AKF is equal to the square ABCD.

7. If a straight line be divided equally and also unequally, the rectangle contained by the unequal parts, and the square on the line between the points of section, are together equal to the square on half the line.

8. In every triangle the square on the side subtending an acute angle is less than the squares on the sides containing that angle, by twice the rectangle contained by either of these sides, and the straight line intercepted between the perpendicular let fall on it from the opposite angle, and the acute angle.

Euclid (Books I.—IV.).—For Senior Civil Service. Time allowed: 3 hours.

1. Define a straight line, an angle, a rectilineal angle, a right angle, a triangle, a rectangle.

What property of straight lines does Euclid really use as a basis of reasoning, and in what proposition does he first use it?

2. Prove that the angles at the base of an isosceles triangle are equal.

3. Define a parallelogram. Prove that the diagonals of a parallelogram bisect one another.

4. Prove that equal triangles on equal bases and on the same side of them, the bases being in one straight line, are between the same parallels.

Hence show that the straight line joining the middle points of two sides of a triangle is parallel to, and equal to half of, the third side.

5. Prove that, if a straight line be bisected and also unequally divided, the squares on the two unequal parts are together double of the squares on the half-line and the line between the points of section.

Show that, if the sum of the two sides of a right-angled triangle which contain the right angle is given, the hypotenuse is least when the two sides are equal.

6. Describe a square equal to a given triangle.

7. Define a circle, a chord of a circle. Prove that every chord of a circle lies entirely within the circle, and that, if the chord be produced, all points in the produced part lie without the circle.

8. Prove that in equal circles equal chords cut off equal arcs, the greater equal to the greater and the less equal to the less.

If the extremities of two equal chords be joined towards the same parts, prove that the joining lines are parallel.

9. Prove that the opposite angles of a quadrilateral inscribed in a circle are together equal to two right angles.

10. If a straight line touch a circle, and, from the point of contact, a straight line be drawn to cut the circle, the angles which it makes with the touching line are equal to the angles in the alternate segments.

11. Show how to inscribe a circle in a given triangle. Prove that the three bisectors of the angles of a triangle meet in one point.

12. Describe an isosceles triangle having each angle at the base double of the vertical angle.

Show that you have obtained two such triangles, and that the centre of the large circle and the two points of intersection of the two circles are the angular points of another.

Mechanics.—For Class D, and for Senior and Junior Civil Service. Time allowed: 3 hours.

1. Explain the terms—resultant velocity, foot-pound, specific gravity, metacentre.

A body is projected with a velocity of 1,000ft. per second at an inclination of 45° to the horizon: find the horizontal and vertical components of this velocity.

2. State and prove the formulæ for the motion of a particle starting from rest under the action of a uniform accelerating force.

3. Find the force which, acting upon a mass of 100lb. for 5 seconds, generates a velocity of 80ft. per second. Find also the acceleration, and the work in foot-pounds which has been done by the force.

4. Show how to obtain by a graphical construction the resultant of three given forces which act at a point.

Four forces, 3, 5, 7, 9, acting at a point, are represented in direction by the sides of a square taken in order: find their resultant.

5. What is meant by the moment of a force?

A rod, 6ft. long and weighing 3lb., has masses of 6lb. and 9lb. attached one to each end: find the position of the point about which it will balance.

6. Find the relation of the power to the weight in the First System of Pulleys.

7. Show that if two liquids that do not mix with one another meet in a bent tube open at the ends, the heights of their upper surfaces above their common surface will be inversely proportional to their densities. Does this proposition hold good if the two branches of the tube have different diameters?

8. A piece of wood floats in sea-water, of specific gravity 1.025, with one-fifth of its volume above the surface: find the specific gravity of the wood.