

2. If two triangles have two sides of the one equal to two sides of the other, each to each, and likewise their bases equal, the angle which is contained by the two sides of the one shall be equal to the angle contained by the two sides equal to them of the other.

3. The opposite sides and angles of a parallelogram are equal to one another, and the diagonal bisects it.

Conversely, prove that a four-sided figure is a parallelogram—(1) if its opposite sides are equal, (2) if its opposite angles are equal, (3) if each diagonal bisects the figure.

4. Given the sum of the side and the diagonal of a square, it is required to construct the square.

5. If a straight line be divided into two equal and also into two unequal parts, the squares of the two unequal parts are together double of the square of half the line, and of the square of the line between the points of section.

6. The opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles.

Show that if the inscribed figure is a parallelogram it must be a rectangle. Investigate the conditions under which the inscribed rectangle has the greatest magnitude.

7. If two circles touch each other externally, and two parallel lines be drawn touching the circles respectively in points A and B so that neither circle is cut, the straight line joining A and B will pass through the point of contact of the circles.

8. If from any point without a circle two straight lines be drawn, one of which cuts the circle and the other meets it: then if the rectangle contained by the whole line which cuts the circle and the part of it without the circle be equal to the square of the line which meets it, the line which meets shall touch the circle.

9. To describe a circle about a given triangle.

If the perpendiculars let fall from the angles A, B of the triangle ABC upon the opposite sides intersect in F, the circle described about the triangle ABF shall be equal to the circle described about the triangle ABC.

10. To inscribe an equilateral and equiangular hexagon in a given circle.

Show that the square of a side of the hexagon is one-third of the square of a side of an equilateral triangle inscribed in the circle.

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

1. Define the units of "velocity" and "acceleration." If the unit of time were changed from a second to a minute, and the unit of length from a foot to a yard, how would the units of velocity and acceleration be affected?

2. Prove the formula for the space passed over when a body falls from rest under the action of gravity.

Find the space which a falling body passes over during the fourth second from rest.

3. Define "work" and "power." What is meant by a "horse-power"?

A ten-horse-power engine is to be employed in pumping water from a mine 440 ft. deep. Taking the weight of a gallon of water as 10 lb., find the number of gallons of water which the engine can raise in an hour.

4. What is meant by a "resultant" force, and by the "composition" of forces? Show how to find the resultant force in direction and magnitude when two equal forces are inclined to one another—(1) at a right angle, (2) at an angle of 120° .

5. If two forces meet at a point, show that the algebraical sum of their moments about any other point in their plane is equal to the moment of their resultant about the same point.

6. Weights of 3 lb. and of 9 lb. are suspended from the ends of a uniform rod weighing 6 lb. Find the length of the rod when it balances about a fulcrum placed 6 in. from its middle point.

7. In a screw press the length of the power arm is $3\frac{1}{2}$ ft., and the thread of the screw makes 20 turns in a length of 3 in.: find the force that must be applied (neglecting friction) to produce a pressure of 11 tons.

8. Describe the barometer, and explain its use.

Taking the average height of the barometer as 29.9 in., and the specific gravity of mercury as 13.6, calculate approximately the ordinary atmospheric pressure.

9. Show that the weight of a floating body is equal to the weight of the liquid which it displaces.

The volume of a piece of metal is 144 cub. in., and its specific gravity is 10.8. If it is supported by a string, find the tension of the string before and after the metal is immersed in water, assuming the weight of a cubic foot of water to be 1,000 oz. avoirdupois.

10. Describe the method of determining the specific gravity of a liquid by Nicholson's hydrometer.

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

1. How would you demonstrate experimentally that liquids expand with heat? Distinguish between the apparent and the absolute expansion of a liquid.

Taking the density of mercury at 0° C. as 13.6, and at 100° C. as 13.558, find the mean coefficient of expansion of mercury between these temperatures.

2. Define the boiling-point of a liquid, and note its chief characteristics. What is meant by the "normal boiling-point" of a liquid? How would you illustrate experimentally the distinction between the "boiling-point" and the "normal boiling-point" of a liquid.