other straight lines, each to each, the first pair make the same angles with one another as the second pair.

5. Parallelograms and triangles upon the same base and between the same parallels are equal.

D, E, F are the middle points of the sides of a triangle ABC, and through A, B, C are drawn three parallel straight lines meeting EF, FD, DE, in a, b, c respectively: prove that the triangle ABC is double of the triangle abc, and that bc passes through A, ca through B, and ab through C.

*6. In any right-angled triangle, the square which is described on the side subtending the right angle is equal to the squares described on the sides which contain the right angle.

If upon the sides AB, AC of any triangle ABC, there be described any parallelograms ABGF and ACED, if the sides GF and ED meet in H, and HA be joined, and if finally upon the third side BC of the triangle a parallelogram BCMN be described whose side BN is equal and parallel to HA, then shall the parallelogram BCMN be equal to the parallelograms ABGF and ACED together. (*Pappus.*)

7. If a straight line be divided into any two parts, the squares on the whole line and on one of the parts are equal to twice the rectangle contained by the whole line and that part together with the square on the other part.

Produce a given straight line so that the sum of the squares on the given line and the part produced shall be equal to twice the rectangle contained by the whole line thus produced and the part produced.

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

Divide a given straight line into two parts such that the square on one of them may be double of the square on the other.

9. To divide a given straight line into two parts so that the rectangle contained by the whole line and one of the parts shall be equal to the square on the other part. (*The golden section.*)

To produce a given straight line to a point such that the rectangle contained by the whole line thus produced and the part produced shall be equal to the square on the given straight line.

II.

FIRST CLASS TEACHERS.

N.B.—Algebraic symbols must not be used.

1. The angles in the same segment of a circle are equal to one another.

If the diagonals AC, BD of the quadrilateral ABCD inscribed in a circle, the centre of which is at O, intersect at right angles in a fixed point P, prove that the feet of the perpendiculars drawn from O and P to the sides of the quadrilateral lie on a fixed circle the centre of which is at the middle point of OP.

2. To inscribe a circle in a given triangle.

If the circle inscribed in a triangle ABC, touch the sides AB, AC in the points D, E, and a straight line be drawn from A to the centre of the circle, meeting the circumference in G, show that G is the centre of the circle inscribed in the triangle ADE.

3. The sides about the equal angles of triangles which are equiangular to one another are proportionals; and those which are opposite to the equal angles are homologous sides, that is, are the antecedents or consequents of the ratios.

If perpendiculars be drawn from any point on the circumference of a circle to the sides of an inscribed quadrilateral, the rectangle under the perpendiculars on two opposite sides is equal to the rectangle under the other two perpendiculars.—(*Pappus' Theorem.*)

4. If four straight lines be proportionals, the rectangle contained by the extremes is equal to the rectangle contained by the means; and if the rectangle contained by the extremes be equal to the rectangle contained by the means, the four straight lines are proportionals.

To bisect a triangle by a straight line drawn through a given point.—*Apollonius.*

5. Similar triangles are to one another in the duplicate ratio of their homologous sides.

To bisect a triangle by a straight line drawn parallel to a given straight line.

NATURAL PHILOSOPHY.

I.

SECOND CLASS TEACHERS AND INTERMEDIATE.

Examiner: J. A. McLellan, LL.D.

1. State the triangle of forces.

A weight of 100 lbs. is suspended by two flexible strings, one of which is horizontal, and the other inclined at an angle of 60° to the vertical; what is the tension of each string?

2. Show how a force can be resolved into two components at right angles to each other.

Show by a diagram how it is possible for a sailing vessel to make headway in a direction at an angle of 60° with that of the wind.

3. What is meant by the moment of a force with respect to a given point? State the principle of moments. The whole length of each oar of a boat is 10 feet, and from the hand to the rowlock the distance is 2 feet; each of your men sitting in the boat pulls his oar with a force of 60 lbs.; supposing the blades of the oar not to move through the water, find the resultant force propelling the boat.

4. A beam, the weight of which is 120 lbs., acting at a point one-fourth of its length from the foot, is made to rest inclined at an angle of 45° against a smooth vertical wall (the other end resting on the ground) by a horizontal force applied to the foot; find this force.

5. Define centre of gravity, and show how the centre of gravity of a body may be experimentally determined.

A uniform triangular slab of marble weighing 120 lbs. is supported by three men at its angular points: find the weight supported by each man.

6. In a system of pulleys in which each pulley hangs by a separate string, there are three pulleys of equal weight; the weight attached to the lowest is 32 lbs., and the power is 11 lbs.; find the weight of each pulley.

7. Explain the principle of virtual velocities, and apply it to find the relation between the power and the weight in a lever of the second order.

8. Define specific gravity. A cylinder whose s. g. is ·6 floats in a fluid with $\frac{3}{4}$ of its bulk below the surface: find the s. g. of the fluid.

9. Describe the *forcing pump.*

The forcing pump being used to raise alcohol (s. g. = ·9) from a lower to a higher level, determine the number of feet which the distance between the lower valve and the surface of the fluid must not exceed, in order that the pump may act, supposing the barometer to stand at 30 inches and the s. g. of mercury to be 13·5.

10. Describe the syphon and explain the principle on which it acts.

Water is flowing out of a vessel through a syphon; what would take place if the pressure of the atmosphere were removed and afterwards restored—(1) when the lower end of the syphon is immersed in water, (2) when it is not?

II.

Examiner: J. C. Glashan.

1. Define *force.* How is it measured?

A mass of 18 oz. lies on a horizontal table. Attached to this mass, by a string passing over a pulley at the edge of the table, hangs a mass of 6 oz. Find the accelerative effect of the weight of the latter mass, assuming the table and the pulley to be perfectly smooth, the string to be weightless and perfectly flexible, and g, the accelerative effect of gravity, = 32.

2. Explain how velocity and rate of change of velocity are measured.

A velocity of 20 yards per minute is changed uniformly in one second to a velocity of twenty-two and a half miles per hour; express numerically the rate of change in feet and seconds.

3. State Newton's Laws of Motion.

(*a*) What is meant by *motion* in the Second Law, and how is it measured?

(*b*) How is *action* measured?

From the Second Law deduce that when a body moves with uniform velocity in a circle, the force acting on the body is directed towards the centre, and is equal to the product of the mass of the body into the square of the velocity divided by the radius of the circle.

4. Deduce the parallelogram of forces from Newton's Laws of Motion.