

7. Show that an angle at the circumference of a circle is equal to, less than, or greater than a right angle according as the arc on which it stands is equal to, less than, or greater than half the circumference.

Find the locus of the middle points of chords of a circle drawn through a fixed point.

8. Show that in any regular polygon the bisectors of the angles all meet in a point.

9. Show how to describe an isosceles triangle having each of the angles at the base double of the third angle. What use does Euclid make of this problem?

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

1. Explain the terms "component," "resolved part," "poundal," "impulse," "energy," "density," "buoyancy."

Find the components of a velocity of 100 units in directions inclined to its own direction, each at an angle of 30 degrees.

2. State the meaning of the letters in the formulæ $s = vt$, $s = \frac{1}{2}vt$, $s = \frac{1}{2}(u + v)t$.

A stone is thrown upwards with a velocity of 100 ft. a second: when will it reach a height of 100 ft., and when will it reach the ground again?

3. A mass of 5 lb. hangs by a string, and is let down with (1) a constant velocity of 5 ft. per second, and (2) with a constant acceleration of 5 ft. per second per second. What is the tension of the string in each case?

4. State the "triangle of forces," and also the extension known as the "polygon of forces."

Three forces are represented in magnitude and direction by three consecutive sides of a square taken the same way round: what is their resultant (1) when they act at a point, (2) when they act along the lines representing them?

5. Show that the sum of the moments of two parallel forces round any point in the same plane is equal to the moment of their resultant.

A rod 5 ft. long is of mass 6 lb., and has masses of 1 lb. and 4 lb. suspended from its extremities: what must be the position of the centre of gravity of the rod that the system may balance about it?

6. If a body is suspended freely at a point, what do you infer about its C.G., and how?

Show how you would experimentally determine the C.G. of any thin plate with plane faces.

7. Describe the requirements of the common balance, and how they are usually satisfied.

Does it matter at what parts of the scales the weights are supported? Give reasons for your answer.

8. If nine-tenths of an iceberg be immersed, what is its density relatively to sea-water?

If the specific gravity of sea-water be 1.026, what is that of the iceberg?

9. If a rectangular vessel, full of water, has its base horizontal, and if an opposite pair of its sides be brought nearer together, how does the pressure on its sides and base vary?

If a body is immersed or is allowed to float in the water, is any change made in the pressure on the sides or on the base of the vessel?

10. Explain the statement "Liquids maintain their level," and mention the necessary conditions.

Why do bubbles in a liquid often cling to the sides or base of the vessel?

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

1. Explain the nature of heat, and state the chief effects of heat.

2. What is meant by the *coefficient of cubical expansion* of a substance?

The volume of a kilogramme of water being 1000 cc. at 4° C., and 1038.7 cc. at 94° C., what is the mean coefficient of expansion of water between these temperatures?

3. Define the normal boiling-point of a liquid, and state the laws of ebullition.

4. If 300 grammes of small shot at the temperature of 100° C. be put into 200 grammes of water at 12° C., and the resulting temperature be 16° C., what is the specific heat of lead?

5. Explain the following terms as used in the theory of sound: *pitch, interval, octave, major third, harmonic*. What harmonics are absent in the note of a closed organ-pipe?

6. Draw a neat diagram illustrating the formation of a real image by a double convex lens. Under what circumstances does the lens produce a virtual image?

If an object placed at the distance of 2 in. from a convex lens has its image magnified five times, find the focal length of the lens (1) when the image is real, (2) when the image is virtual.

7. What is meant by a *magnetic field*, and by *lines of magnetic force*? Give a rough sketch of the direction of the lines of magnetic force when two bar magnets are laid parallel to one another with their like poles pointing in opposite directions.

8. Describe the Leyden jar, and explain its use.

9. Describe in detail the arrangements which you would make in order to electrolyse water, and to collect the resulting gases.

10. The E.M.F. of a bichromate cell is 1.92 volt, and its internal resistance is $\frac{1}{2}$ ohm: find the current which it gives when its poles are connected by a wire of 5 ohms resistance.

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

1. Explain, giving a sketch of the apparatus, how you would make and collect ammonia gas from ammonium-sulphate.

2. How would you remove from atmospheric air (a) its carbon-dioxide; (b) its oxygen; (c) any ammonia gas it might contain? State what gases would be left after the removal of these.