

If two circles intersect one another, the common chord produced will bisect the common tangent.

7. Show that the centre of the circle which touches the two semicircles described on the sides of a right-angled triangle is situated at the middle point of the hypotenuse.

8. To inscribe an equilateral and equiangular pentagon in a given circle.

9. The square on the side of an equilateral triangle inscribed in a circle is treble of the square on the side of a regular hexagon inscribed in the same circle.

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

1. Distinguish between the *mass*, the *weight*, and the *specific gravity* of a body; and between the *velocity*, the *acceleration*, and the *kinetic energy* of a body in motion.

2. A projectile discharged vertically upwards occupies two seconds in rising to a height of 96 ft.: find the whole height to which it will rise, and the whole time of ascent.

3. Define *force* and *work*, and explain how they are respectively measured.

A force equal to the weight of 20 lb. acts upon a mass of 75 lb.: find the acceleration, and the work done by the force per minute.

4. Show how the resultant of two forces, and of three forces, acting at a point may be obtained by a graphical construction.

A body weighing 12 oz. is suspended from a fixed point by a string 10 ft. long, and is drawn aside by a horizontal force to a distance of 6 ft. from the vertical line through the point of suspension: required the tension of the string.

5. What is meant by the *moment* of a force? Show that the moments of two forces about any point in the line of action of their resultant are equal and opposite.

A thin rod, without weight, has balls of 1 oz., 3 oz., and 5 oz. weight attached to it at distances of 2 ft., 4 ft., and 6 ft. respectively from one end: how far from the same end is the point at which the rod must be supported in such a way that it shall remain in a horizontal position?

6. Define the *centre of gravity* of a body. If the positions of the centre of gravity of a body and of the centre of gravity of a portion of the body are given, show how to find the position of the centre of gravity of the remaining portion of the body.

7. Find the relation of the *power* to the *weight* in the first system of pulleys, in which each string is attached to the supporting beam, friction and the weights of the pulleys being neglected. What is the mechanical advantage where there are five movable pulleys?

8. A cubical vessel, whose edge is 1 ft., is filled with mercury. Taking the specific gravity of mercury as 13.6, find the pressures on the base and on one side of the vessel.

9. Show how to find the specific gravity of a mixture of substances whose volumes and specific gravities are known.

A piece of plated ware weighs 60 oz., and its specific gravity is found to be 8.1. Supposing the specific gravities of the unplated metal and of silver to be 7.5 and 10.5 respectively, find the weight of the silver.

10. State Boyle's law, and explain how the law may be experimentally verified.

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

1. Explain how the fixed points of a mercury thermometer are determined. Why is it necessary to observe the barometer in determining one of the fixed points and not the other?

2. Describe fully a method of determining the coefficient of expansion of a liquid.

3. Distinguish between "evaporation" and "ebullition." State the circumstances which affect the rapidity of these actions in the case of a liquid contained in an open vessel.

4. Define "latent heat." What numbers express the latent heats of water and of steam?

If 100 grams of steam at 100° C. be led into a vessel containing a kilogram of snow at 0° C., how much of the snow will remain unmelted?

5. Explain the following terms as used in the theory of sound: *Node*, *wave-length*, *pitch*, *musical interval*, *major third*. On what circumstances does the pitch of the note emitted by a stretched string depend?

When a stopped pipe, 4 ft. long, and an open pipe, 6 ft. long, are sounded, what is the interval between the notes?

6. Show that when an object is placed midway between a concave mirror and its principal focus, or midway between the principal focus and the centre of curvature, the image in either case is twice the size of the object. What is the character of the image in each of these cases?

7. State the laws of the refraction of light. Under what circumstances does "total reflection" take place at the surface of a transparent body? What is the relation between the "critical angle" and "refractive index" of the substance?

8. What is meant by a "magnet-pole"? Define *unit strength of pole*, and *unit intensity of a magnetic field*.

A magnet-pole of strength 12, when placed in a magnetic field, is acted on by a force of 30 dynes; what is the intensity of the magnetic field?

9. Describe the essential parts of a frictional electrical machine, and explain its action.

10. Describe Grove's cell. How are cells connected "in series," and "in parallel"?

If six Grove's cells are connected in series, each cell having an EMF of 1.95 volt and an internal resistance of $\frac{1}{8}$ ohm, what current will they give through an external resistance of 12 ohms?