

9. Describe the siphon, and explain its action.

10. Define centre of pressure. Does the centre of pressure on a surface necessarily coincide with the centre of gravity of the surface, or does it ever do so? Give reasons for your answer.

A cylindrical vessel, $3\frac{1}{2}$ in. in diameter and 8 in. high, is filled with mercury. Taking the weight of a cubic inch of mercury as $\frac{1}{2}$ lb., find the whole pressure (1) on the base of the vessel, (2) on the curved surface.

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

1. Give an account of the chief physical changes produced in bodies by heat.

2. What is meant by "latent heat"? Explain the cause of the change of temperature when common salt is mixed with snow. How much heat would be required to convert a kilogramme of ice at 0° C. into steam at 100° C.?

3. Define "specific heat." How would you show that the specific heat varies for different substances?

A quantity of mercury at 0° C. is stirred up with an equal volume of water at 50° C. Find the resulting temperature, having given that the density of mercury is 13.6, and its specific heat 0.033.

4. What is meant by the "dew-point"? Explain the principle of some kind of dew-point hygrometer.

5. Explain the causes of the following phenomena: Echo, resonance, beats, overtones.

6. Explain the term "conjugate foci," as applied in the case of a spherical concave mirror. Can the conjugate foci both be real? Can they both be virtual? Under what circumstances will one be real and the other virtual?

An object is placed 4 ft. from a wall, and an image of the object magnified five times is thrown by a concave mirror upon the wall: where is the mirror placed and what is its focal length?

7. What is a Leyden jar? How is it charged? Obtain an expression for the energy of the charge. Describe an experiment which proves that the energy of the charge is stored up in the glass.

8. What is the cause of polarisation in a voltaic cell, and what is its effect on the action of the cell? Explain how polarisation is avoided in the Daniell cell.

9. A telegraph-line is 70 miles in length, and has a resistance of 14 ohms per mile. How many Daniell's cells joined in series, each cell having an E.M.F. of 1.08 volt and an internal resistance of 5 ohms, will be required to send a current of 0.02 ampere through the line?

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

1. Describe, giving the equations, three processes for making oxygen gas.

2. In what respects do the allotropic forms of phosphorus differ from each other?

3. Explain (giving full details, also giving equations) how bromine is got from sea-water.

4. How many grams of hydrogen gas can be got by the action of sulphuric acid on 1,000 grams of zinc? (At. wt. of Z = 65.)

5. Explain (giving also the equations) three processes for making carbonic-oxide gas.

6. Explain as fully as you can (giving equations) how sulphuric acid is made on the large scale.

7. Give the names and formulæ of all acids that contain (a) chlorine, (b) sulphur, (c) phosphorus.

8. Explain (with equations) how to make each of the oxides of nitrogen.

9. How can sulphuretted hydrogen be best made for laboratory experiments?

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

Animal Physiology.

1. Describe fully the structure of the heart of any mammal, and explain the functions of the various parts.

2. Describe the microscopical structure of a long bone, as seen in transverse and longitudinal sections.

3. How do we become sensible of vibrations of the air? Describe the structure of any special sense-organ concerned in their perception.

4. What are waste products? Enumerate the principal waste products of the human body, and explain how they are got rid of.

5. Explain fully the mechanism of respiration in man.

6. What is the scurf of the hair? Explain as fully as possible how it is formed. Draw and describe a vertical section through the roots of the hair.

7. What is an egg? How does an egg become an animal?

8. State what you know of the structure of the small intestine in man, and describe the functions of the various parts.

Botany.

1. Refer the following plants to their proper natural orders, and give the principal characters of each order: *Veronica*, *aster*, *trifolium* (clover), *cordyline* (cabbage-tree).

2. Explain the meaning of the terms *open*, *closed*, *collateral*, and *concentric*, as applied to vascular bundles, and describe the bundles of any plants which exhibit these characters.

3. From what sources do green terrestrial plants obtain their supplies of oxygen, nitrogen, carbon, and water respectively? Why is oxygen required by plants?