

5. A uniform beam, 18ft. long and weighing 60lb., rests upon two supports, which are 5ft. distant from the ends of the beam: find the pressures upon the supports when a weight of 40lb. is placed upon one end of the beam.

6. Find the position of the centre of gravity of a plane triangular lamina of uniform thickness.

7. What force, acting horizontally, will be necessary to support a weight of 80lb. on a smooth inclined plane, the height of which has to its length the ratio of 3:5? and what will be the pressure on the plane?

8. Show that the pressure at any point within a liquid which is free from external pressure is proportional to the depth of the point below the surface of the liquid.

Find the pressure per square inch at the depth of 18in. in mercury, the specific gravity of mercury being 13.6.

9. Describe the common air-pump.

10. A sovereign weighs 123 grains, and loses in water 6.63 grains of its weight: find its specific gravity. It consists of eleven parts of pure gold, of specific gravity 19.3, and one part of alloy: find the specific gravity of the alloy.

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

1. A cubic foot of water at 20° C. is cooled down until it is completely frozen. Describe the changes which take place in its volume. Assuming that the weight of the water is 62½lb., calculate the quantity of heat which it has given out.

2. What is meant by the specific heat of a substance? Is the specific heat of a substance affected by change of temperature, or by change of state?

A quantity of small shot, weighing 20oz., is raised to the temperature of 100° C., and thrown into 18oz. of water at 10° C. If the resulting temperature is 13° C., find the specific heat of lead.

3. Describe the cryophorus, and explain the principles which it illustrates.

4. Give an account of the diatonic musical scale. If the vibration number of C is 258, what are the vibration numbers of F and A?

5. Define "refractive index" and "critical angle." Show how to construct the critical angle for a substance the refractive index of which is  $\frac{3}{2}$ . Explain the phenomenon of mirage.

6. Explain how a beam of white light may be resolved into its constituent colours by means of a prism. Draw a diagram showing the course of the rays, and the order of the spectral colours.

7. What is meant by the "magnetic meridian" and the "magnetic dip"? Rods of steel, soft iron, and copper are placed with their lengths parallel to the magnetic dip, are tapped with a hammer when in this position, and are then removed: state the effects, if any, which are produced in each case.

8. You desire to show that the electrical density is greater at the apex than on the plane base of a charged metal cone. What apparatus would you require, and how would you conduct the experiment?

9. State Ohm's law.

How many bichromate cells, each having an E. M. F. of 2 volts and an internal resistance of  $\frac{1}{4}$  ohm, will be required to give a current of 0.32 ampere through an external resistance of 24 ohms?

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

1. Show, by equations, the effect of heat on the following compounds: (1) *Phosphoric acid*, (2) *sulphuric acid*, (3) *ammonic chloride*, (4) *potassic chlorate*, (5) *peroxide of hydrogen*, (6) *phosphorous acid*.

2. Describe (giving the equations) a process for the manufacture of *ammonia* from the ammoniacal liquor of gasworks.

3. Describe fully (giving the equations) the manufacture of *sulphuric acid* on the large scale; or, the manufacture of *phosphorus* from bones.

4. Arrange the nonmetallic elements in vertical columns under the following heads: *Monads*, *dyads*, *triads*, *tetrads*, *pentads*, *hexads*, *heptads*.

5. Required about half a litre of each of the following gases: (a) Nitrous oxide, (b) nitric oxide, (c) carbonic oxide, (d) carbonic anhydride, (e) sulphur dioxide, (f) chlorine. Show how you would make and collect them.

6. A colourless gas in a clear glass jar is known to be one of the following: *Oxygen*, *nitrous oxide*, *nitric oxide*, *carbonic anhydride*, *hydrogen*. How would you determine which of them it is?

7. Express in grammes the weight of 100 litres of each of the following gases at normal temperature and pressure (0° C. and 760mm.): *Oxygen*, *chlorine*, *nitrogen*, *nitrous oxide*, *ammonia*, *carbon dioxide*. [1 litre of hydrogen at normal temperature and pressure = .0896 gramme.]

8. State what you know of the allotropic forms of *sulphur*, or of *phosphorus*.

9. Enunciate the following laws:—

(1.) Dalton's law of "constant proportion."

(2.) Dalton's law of "multiple proportion."

(3.) Dalton's law of "reciprocal proportion."

(4.) Avogadro's "law of volumes."

(5.) The law of the "diffusion of gases."