

4. A steam-engine of 5-horse power is employed to raise water by a forcing-pump to the height of 150 feet. How many gallons of water will it raise per day of 10 hours? [1-horse power = 550 foot-pounds per second; 1 gal. = 10lb.]

5. What is meant by the "resultant" of two or more forces?

Find the resultant of two forces, each equal to the weight of 12lb., which act upon a particle at an inclination of 60° to one another.

6. When three parallel forces are in equilibrium, show that the algebraical sum of the moments of the forces about any point in the plane of the forces is equal to zero.

7. Find the relation of the power to the weight in the "first system" of pulleys (that in which each pulley hangs by a separate string).

In the system of pulleys in which each string is attached to the weight, the power is 18lb., and the weight is 270lb. What is the number of moveable pulleys?

8. Show how it may be proved, experimentally, that a pressure applied to any portion of the surface of a confined fluid is transmitted equally in every direction through the whole fluid.

9. Describe the method of determining the specific gravity of a solid by the hydrostatic balance, explaining the principle on which the method depends.

In a glass of spirits, whose specific gravity is 0.91, a cork floats with five-sevenths of its volume unimmersed. What is the specific gravity of the cork?

10. Describe the action of the air-pump.

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

1. Distinguish between "temperature" and "quantity of heat," and explain how each is measured.

2. What is meant by the term "latent heat"?

Steam at 100°C . is passed into a vessel containing 1lb. of snow at 0°C . till the snow has been melted and the temperature of the resulting water raised to 34°C . Supposing the heat absorbed by the vessel to be negligible, find the weight of steam that has been condensed.

3. Define "specific heat." How is the specific heat of a substance affected by temperature, and by change of state? What relation has been found to exist between the specific heat of simple substances and their atomic weights?

4. Explain the phenomena of "resonance," "beats," and "harmonics" in the theory of sound.

5. When the flame of a candle is placed in the axis of a concave mirror at the distance of 2ft., its image is formed at the distance of 16in. from the mirror: find the radius of curvature of the mirror.

6. State the law of the refraction of light. Under what circumstances does "total reflection" take place at the bounding surface of a transparent body? Construct the "critical angle" for the common surface of water and air.

7. Distinguish between a "magnet" and a "magnetic substance." What is a "diamagnetic substance"? Describe how a steel bar may be magnetized, (1) by means of a magnet, (2) by means of an electric current.

8. Explain the action of a frictional electrical machine.

9. What are the chief effects of the electric current? Which of these effects is the most convenient for measuring the intensity of the current? Describe the several means that are employed to increase the sensitiveness of a galvanometer.

10. Define the practical units of E.M.F. and resistance. On what circumstances does the resistance of a conductor depend?

If the resistance of an iron telegraph wire, $\frac{1}{4}$ in. in diameter, be 11 ohms per mile, what will be the resistance of 100yds. of copper wire, $\frac{1}{16}$ in. in diameter, supposing the specific resistance of iron to be six times as great as that of copper?

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

1. Starting with phosphorus, how would you make (a) phosphoric anhydride, (b) ordinary phosphoric acid?

2. Explain how nitrous oxide gas is made. Give the equation.

3. Given the three gases, oxygen, nitrous oxide, nitric oxide, how would you distinguish them from each other?

4. What is the composition of atmospheric air? How is it proved that it is a mixture of gases, and not a compound?

5. Describe (giving equations) the manufacture of ammonia on the large scale.

6. Write down the names and formulæ of all the compounds that hydrogen forms with each of the other non-metallic elements.

7. Write down the names and symbols and atomic weights of all the members of (a) the halogens, (b) the oxygen family, (c) the nitrogen family of elements.

8. In what respects do sulphur, selenium, and tellurium resemble each other?

9. In what respects do chlorine, bromine, and iodine (a) resemble each other, and (b) differ from each other?

10. What are the various methods of preparing hydrogen gas for experimental purposes? Give the equations.

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

[Zoology.—Alternative with Botany.]

1. Describe the minute structure of the lungs. What is the purpose of the respiratory process, and how is it effected?