

between the hand and the bundle be kept constant, and the distance between the hand and the shoulder be changed, how does the force on his shoulder change?

4. Weights of 5, 6, 9 and 7 pounds respectively are hung from the corners of a horizontal square, 27 inches in the side; find, by taking moments about two adjacent edges of the square, the point where a single force must be applied to the square to balance the effect of the forces at the corners.

5. What is meant in mechanics by "acceleration"?

A mass of 19 pounds and a mass of 5 pounds are connected by a string which passes over a pulley at the edge of a horizontal table, so that the smaller mass hangs vertically, and, by its weight, pulls the larger mass along the table.

Determine the acceleration, friction being neglected.

6. Explain how to use Atwood's machine to show—

(1) That a body acted on by a constant force moves with uniform acceleration;

(2) That the acceleration of a given mass is proportional to the force which acts upon it.

7. While a railway train travels  $\frac{1}{2}$  a mile on a level line, its speed increases uniformly from 15 miles an hour to 30 miles an hour; show what proportion the pull of the engine bears to the weight of the train—neglect friction.

### B.

8. A piece of iron, weighing 275 grammes, floats in mercury of density 13.59 with  $\frac{2}{3}$  of its volume immersed; determine the volume and density of the iron.

9. A piece of glass weighs 47 grammes in air, 22 grammes in water, and 25.8 grammes in alcohol; find the specific gravity of the alcohol, and state the general principle on which the solution of the problem depends.

Describe some form of condensing air-pump. If the capacity of the barrel of the pump be 80 cub. cm., and the capacity of the receiver 1,000 cub. cm., how many

strokes will be requisite to raise the pressure of the air in the receiver from one atmosphere to four atmospheres?

11. What is meant by saying that the refractive index of water with respect to air is  $\frac{4}{3}$ ?

If the refractive index of water with respect to oil of turpentine be  $\frac{7}{6}$ , show how to find the refractive index of oil of turpentine with respect to air.

12. A candle is placed at a fixed distance opposite a wall. A convex lens held between the candle and the wall, throws on the wall a well-defined magnified image of the candle-flame when it is one foot from the candle, and a well-defined diminished image when it is eleven feet from the candle. Find the focal length of the lens.

13. 200 cub. cm. of water at 99° C. are mixed with 200 cub. cm. of milk of density 1.03 at 15° C., contained in a copper vessel of thermal capacity equal to that of 8 grammes of water, and the temperature of the mixture is 57° C. If all the heat lost by the water is gained by the milk and the copper, what is the specific heat of the milk?

14. A glass flask contains, when full at 9° C., 100 cub. cm. of mercury. The co-efficient of cubical expansion of glass being 0.000026, and that of mercury 0.000018, find the volume at 100° C. of the mercury driven out when the flask and mercury are heated to 100°.

15. Three separate mixtures are made, namely:—

(1) Water and snow.

(2) Water and salt.

(3) Snow and salt.

If all the materials were, before being mixed, at 0° C., which mixture will be at the highest temperature, and which at the lowest, and why?

16. A glass bottle and a bottle of porous earthenware are both filled with water and exposed to the air side by side. Usually, the water in the earthenware bottle becomes decidedly colder than that in the glass, why is this? If there is little or no difference of temperature, what conclusion may we draw as to the state of the atmosphere? and why?