

- 10 8. BODF is a four-sided figure, having the side BO parallel to the side FD. If BD and FO be joined by straight lines intersecting in K, show that the lines BD and CF are together greater than the two lines BF and OD, also that the triangle CKD is equal to the triangle BKF.
- 10 9. ABCD is a rectangle, E any point in BC, and F any point in CD. If AF, AE and EF be joined, show that the rectangle ABCD is equal to twice the triangle AEF, together with the rectangle EB DF.
- 10 Produce one side of a scalene triangle so that the rectangle under it and the produced part may be equal to the difference of the squares on the other two sides.

SOLUTIONS.

2. (b) The angle EDG is made at D in ED, the side which is not the greater of the two DE, DF. If this were not done, three different cases would arise,—the point G might fall above, on or below EF.

7. Let A be the point through which the line is to be drawn and B, C the other two points. Bisect BC in D; join DA, and through A draw bAc perpendicular to AD. Then if Bb, Cc be perpendicular to bAc, we may readily prove bA, cA equal.

8. (1) $BK + KF > BF$, and $CK + KD > CD$; $\therefore BD + CF > BF + CD$.

(2) Because BC is parallel to FD, the triangles FBC, DBO are equal. Take away the common triangle KBC, and the remainders of the triangles KBF, KCD are equal.

9. Through E, F draw EG, FG parallel to the sides, and meeting in G within the triangle. The rectangle AC is equal to the rectangles BE.DF + BE.CF + EC.DF + EC.CF, of which the latter three are respectively double the triangles AEG, AFG, EFG, which make up the triangle AEF.

10. Let ABC be the triangle. To BC apply a rectangle BODE equal to the difference between the squares on AB, AC; and in BC produced take CF equal to CD.

NATURAL PHILOSOPHY.

TIME—TWO HOURS AND A HALF.

Examiner—J. J. TILLEY.

Value of each of the first six questions 13, and of each of the last three 14.

1. What conditions are necessary so that three forces acting on a body may maintain equilibrium?

Show how the following forces may be arranged so as to produce equilibrium:—(i.) 4 lbs., 5 lbs. and 7 lbs. (ii.) $(\sqrt{7} + \sqrt{5})$ lbs. $(\sqrt{7} - \sqrt{5})$ and $2\sqrt{7}$ lbs. (iii.) 1 lb., 4 lbs. and $\sqrt{17}$ lbs.

2. Examine the truth of the following statement:—"If three forces acting on a body are parallel to the sides of a triangle they will keep it at rest."

A rod AC (supposed without weight) hinged at C, has a weight of 200 lbs. hung at A, and is kept in position by a horizontal tie-rod AB. The angle BAB is 80° ; find the tension of the tie-rod and the thrust along AC.

3. If two sides of an equilateral triangle, take in order 8 ft. long represent in direction and magnitude two forces acting at a point, find two equal forces, acting at an angle of 120° to each other, which will, with these forces, produce equilibrium.

4. In a system of four pulleys, each hanging by a separate string, the weight of each pulley being 1 lb. find the relation between the power and the weight.

If a force of $2\frac{1}{2}$ lbs. just supports a weight of 45 lbs. in such a system, and the weight of the pulleys be equal, find the weight of each pulley.

5. If a substance be weighed in a balance having unequal arms, and in one scale appear to weigh m lbs. and in the other n lbs.

what is the true weight of the substance, and what is the ratio between the lengths of the arms of the balance?

6. Find the ratio of the power to the weight in the case of the inclined plane when the power acts [i.] parallel to the plane, [ii.] parallel to the base.

Show that the power is most effective when acting parallel to the plane.

7. Define Specific gravity, and show how to find the specific gravity of a body lighter than water.

A piece of wood weighs 4 lbs. in air and a piece of lead weighs 5 lbs. in water. The lead and the wood together weigh 4 lbs. in water; determine the specific gravity of the wood.

8. Describe, using diagram, the structure of the lifting pump. What determines the height to which water may be raised by means of it?

Describe the thermometer. At what temperature will the reading of the Fahrenheit thermometer be three times as great as that of the Centigrade? Give your answer in degrees Fahrenheit.

9. A cubical block of wood whose edge is 18 inches and whose sp. gr. is .75 is placed in water and pressed by a force into such a position that its upper surface, which is horizontal, is just one foot below the surface of the water; find the pressure on the whole outside of the cube, and the downward force acting upon it.

SOLUTIONS.

1. (i) Take AB a line = 4; from it cut off AC = 1; draw CD perpendicular to AB, and from centre A with radius 5 describe a circle, cutting CD in D. Then the forces 4, 5 act along AB, AD, the force 7 will act opposite to the diagonal of the parallelogram of which AB, AD are adjacent sides. (ii). The two first forces act together in a straight line and the force $2\sqrt{7}$ directly opposite to them. (iii). 1 and 4 act at right angles, and $\sqrt{17}$ opposite to the diagonal of the parallelogram of which the former are adjacent sides.

2. Suppose BC vertical; then the tension, thrust and weight are proportional to AB, AC, BC. Hence tension = $200\sqrt{3}$, and thrust = 400.

3. The angle between the directions in which the forces act is 120° . Hence the required forces must act along one side of the triangle and opposite to the other, and will be equal to the other two forces.

$$4. P = \frac{W}{16} + \frac{1}{16} + \frac{1}{8} + \frac{1}{4} + \frac{1}{2}; \text{ or } 16P = W + 15.$$

$$2\frac{1}{2} = \frac{45}{16} + \frac{\text{wt. of pulley} \times 15}{16}; \text{ i.e., wt. of pulley} = -\frac{1}{8}.$$

We suppose the pulleys are lighter than the surrounding medium, and therefore are buoyed up with a force = $\frac{1}{8}$ lb.

5. Let a, b be the lengths of the arms and x the weight of the substance. Then $ax = bm$, also $bx = 4an$; $\therefore abx^2 = 4mnab$ or $x = 2\sqrt{mn}$.

$$\text{Also } \frac{a}{b} = \frac{bm}{4an}, \text{ or } \frac{a^2}{b^2} = \frac{m}{4n}, \text{ or } \frac{a}{b} = \frac{1}{2}\sqrt{\frac{m}{n}}.$$

7. The wood is buoyed up in the water with a force of 1 lb. Hence wt. of water displaced by wood = 1 lb. + wt. of wood = 5 lbs. $\therefore$ sp. gr. of wood = $\frac{4}{5} = .8$.

8. Let x = required temperature Fahr. Then $(x - 32) \frac{9}{5} =$ this temperature expressed in Centigrade. Hence $x = 3(x - 32) \frac{9}{5}$, or $x = 80^\circ$.

9. Vol. of cube = $\frac{27}{8}$ cub. ft., surface = $\frac{9}{4} \times 6 = 13\frac{1}{2}$ ft.; depth of its centre of gravity = $1\frac{1}{4}$ ft.

$$\therefore \text{pressure on surface} = 13\frac{1}{2} \times 1\frac{1}{4} \times 1000 \text{ oz.} = 28625 \text{ oz.}$$

$$\text{Downward force} = \text{upward press. of displaced H}_2\text{O} - \text{wt. of cube} = \frac{27}{8} \times 1000 - \frac{27}{8} \times 1000 \times .75 = \frac{27}{8} \times 1000 \times \frac{1}{4} = 843\frac{1}{2}.$$

Want of space compels us to hold over our correspondence until next month's issue.