SOLUTIONS OF QUESTIONS IN A COURSE OF NATURAL PHILOSOPHY

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IN

A COURSE OF

NATURAL PHILOSOPHY.

BY

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MDCCCLXXIII.

SOLUTIONS OF EXERCISES.

STATICS.

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(1.) 18 lbs. : 168 lbs. : : 3 ft. : 28 feet.

(2.) 36 in. : 17 in. : : 18 lbs. : $8\frac{1}{2}$ lbs.

(3.) The larger force is $\frac{4}{5}$ of the single force, therefore the smaller force is $\frac{1}{5}$ of the single force.

(4.) 64 in. : 7 in. : : 20 cwt. : 2 cwt. 21 lbs.

(5.) 6 cwt. : $\frac{720}{1728}$ cwt. of 6 : : 12 in. : 5 inches.

(6.) It is required to find two numbers the sum and difference of which are respectively 12 and 2.

$x + y = 12;\ x - y = 2\ \therefore x = 7,\ y = 5.$

(7.) Tensions are 4, $4 + 5 = 9$, $4 + 5 + 7 = 16$. 9 lbs. : 4 lbs. : : $11\frac{1}{4}$ in. : 5 inches; 9 lbs. : 16 lbs. : : $11\frac{1}{4}$ in. : 20 inches.

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(12.) $R = \sqrt{63^2 + 16^2} = 65.$

(13.) $R = \sqrt{84^2 + 13^2} = 85.$

(14.) $Q = \sqrt{(113 + 112)\ (113 - 112)} = \sqrt{225 \times 1} = 15.$

(15.) Here $\sqrt{(33a)^2 + (56a)^2} = 65a$.
But $65a = 130$ $\therefore$ $a = 2$
wherefore $P = 33 \times 2 = 66$, and $Q = 56 \times 2 = 112$.

(16.) $P = \sqrt{(85 + 77)\ (85 - 77)} = \sqrt{162 \times 8} = 36$.

(17.) $Q = \sqrt{(30.5 + 27.3)\ (30.5 - 27.3)} = \sqrt{57.8 \times 3.2} = 13.6$.

(18.) Let x = resultant; larger force $= 259.2 - x$.
$x^2 = 7.2^2 + (259.2 - x)^2$.
$x^2 = 51.84 + 51.84 \times 1296 - 518.4\,x + x^2$.
$\therefore x = 129.7$; $259.2 - 129.7 = 129.5$.

(19.) Complete the parallelogram. It will be seen that the oblique force is inclined at an angle of 45°, and is equal to the square root of twice the vertical force.

(20.) Let $P = 16a$, then $Q = 63a$; hence $R = \sqrt{(16a)^2 + (63a)^2} = 65a$. But $65a = 13$, therefore $a = \frac{1}{5}$. Therefore $\frac{16}{5} = 3.2$ and $\frac{63}{5} = 12.6$ are respectively the two forces.

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(1.) From formula Sec. 24. $R^2 = P^2 + P^2 + P^2 = 3\,P^2 = 3 \times 15^2$ $\therefore$ $R = 15\,\sqrt{3}$.

(2.) $R^2 = P^2 + P^2 + P^2 \times \sqrt{3} = 20^2 + 20^2 + 20^2\,\sqrt{3} = 692.8$ $\therefore$ $R = 26.32$.

(3.) $R^2 = P^2 + P^2 + P^2 \times \sqrt{2} = 40^2 + 40^2 + 40^2\,\sqrt{2} = 5462.4$ $\therefore$ $R = 73.9$.

(4.) See Section 20, II. deduction.

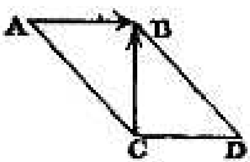
(5.) $R^2 = P^2 + P^2 - P^2\,\sqrt{2} = 100^2 + 100^2 - 100^2\,\sqrt{2} = 5860$ $\therefore$ $R = 76.5$.

(6.) $R^2 = P^2 + Q^2 - PQ = 10^2 + 42^2 - 420 = 1444$ ∴ $R = 38$.

(7.) $R^2 = P^2 + Q^2 + PQ = 8^2 + 12^2 + 96 = 304$ ∴ $R = 17.43$.

(8.) $R^2 = P^2 + Q^2 - PQ = 9^2 + 11^2 - 99 = 103$ ∴ $R = 10.14$.

(9.) Let A B and C B represent P and R respectively. Complete the parallelogram. D B represents force Q, and being the hypothenuse of △ B D C, is greater than B C.



(10.) $R^2 = P^2 + P^2 - P^2 \sqrt{3} = 2 \times 50^2 - 50^2 \times \sqrt{3} = 670$ ∴ $R = 25.88$.

(11.) At 120°. See Section 20, II. deduction.

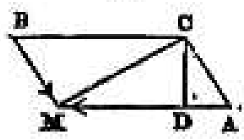
(12.) $R^2 = P^2 + P^2 + P^2 = 3\ P^2$

$3\ P^2 = 8100$; $P^2 = 2700 = 900 \times 3$ ∴ $P = 30\ \sqrt{3}$.

(13.) Construct the figure (see fig. in Ex. 9 above). Horizontal force equals the vertical force. Oblique force equals square root of twice the vertical force.

(14.) $R^2 = P^2 + P^2 = 2\ P^2$ and $P^2 = \frac{10^2}{2} = 50$ ∴ $P = 7.07$.

(15.) $R^2 = P^2 + P^2 - P^2 \sqrt{2} = P^2 (2 - \sqrt{2}) =$ $P^2 = \frac{100}{2 - \sqrt{2}} = \frac{100\ (2 + \sqrt{2})}{2} = 170.7$ ∴ $P = 13.065$.



(16.) See Figure. $C D = \frac{55}{2}$, $D A = 27.5\ \sqrt{3}$.

$MD = \sqrt{(95 + 27.5) \times (95 - 27.5)} = \sqrt{122.5 \times 67.5}$
$= \sqrt{49 \times 5 \times .5 \times 9 \times 3 \times 5 \times .5} = \sqrt{7^2 \times 5^2 \times .5^2 \times 3^2 \times 3}$
$= 7 \times 5 \times .5 \times 3\sqrt{3} = 52.5\sqrt{3}.$

Then $(M\ D + D\ A)$ the other component $= 52.5\sqrt{3} + 27.5\sqrt{3} = 80\sqrt{3}.$

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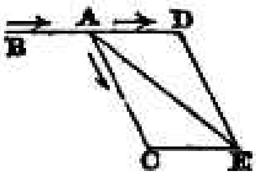
(1.) See Section 30.

(2.) Two of the forces are in the same straight line, and neutralize each other, leaving as resultant the third force.

(3.) Here the two equal forces P and R act at an angle of 120°. Their resultant is, therefore, equal to one of them, and bisecting the angle acts in the same direction as the force Q. Total resultant is therefore 10 lbs.

(4.) If we take the forces in order, we find that the first and third forces are of 5 lbs. each, are exactly opposite to other forces of 5 lbs., and are therefore neutralized. We have, also, three forces of 8 lbs. each, acting at right angles to each other. Two of them act in opposite directions in the same straight line, and are therefore neutralized. We have then left as resultant one force of 8 lbs.



(5.) Let B A and A C represent the two forces. The pushing force, or thrust, B A, may be replaced by the equal drawing force, or strain, A D. Complete the parallelogram. The diagonal A E represents the resultant.

(6.) $\sqrt{119^2 + 120^2} = \sqrt{28561} = 169.$

Since resultant 169 is equal to square root of the sum of the two forces, therefore the angle between them must be a right angle.

(7.) $R^2 = P^2 + P^2 = 2 P^2$

$$P^2 = \frac{100}{2} = 50 = 25 \times 2$$

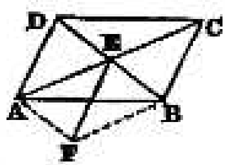
$$P = 5 \sqrt{2}.$$

(8.) $\sqrt{44^2 + 117^2} = \sqrt{15625} = 125$

$$\therefore AB = 125.$$

Now, if a triangle A′ B′ C′ be drawn equal in all respects to A B C turned through 90°, its sides will be parallel to, and therefore proportional to, the forces. Hence, 125 in. represents a weight of 10 lbs., therefore 1 in. represents ·08 lbs.; 44 inches represent 44 × ·08 = 3·52 lbs.; and 117 represents 117 × ·08 = 9·36 lbs.

(9.) Let A C, B D be the diagonals intersecting in E. On A E, B E make the parallelogram A E B F, and join E F. Because D E is parallel and equal to A F, therefore F E is parallel and equal to A D. Now, forces represented by A E, B E will be half the forces represented by A C, B D; and F E, the resultant of the former, will therefore be half the resultant of the latter. Hence, this resultant is twice the force represented by A D.



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(1.) See Section 38.

(2.) The magnitude of resultant = (18 + 12) = 20 lbs.