cubic foot, would balance a 30-inch column in a mercury barometer, the specific gravity of mercury being 13·596, (water = 1)?

NATURAL PHILOSOPHY, SOLUTIONS.

1. Constructing a triangle whose sides are parallel to the three forces (weight, reaction of plane, and tension of string), we shall find that these sides are as $\sqrt{3} : 1 : 1$; i.e., $\frac{100}{\sqrt{3}} = \frac{T}{1} = \frac{R}{1}$.

2. The cr. of gr. is at distances $5\frac{1}{2}$ and $4\frac{1}{2}$ ft. from the supports. Taking moments about the point of support nearer the end of the bench, we have (if P be the pressure on the other support) $150 \times 5\frac{1}{2} = P \times 10$; $\therefore P = 82\frac{1}{2}$ lbs.; $\therefore$ pressure on other bench $= 67\frac{1}{2}$ lbs.

3. Let W be the weight of the plank, a and b the distances of the support from the centre of gravity of the beam, and the end to which the 200 lbs. is attached. Then $200b = Wa$, $120(b + 2) = W(a - 2)$, $60(b + 4) = W(a - 4)$; whence $W = 860$ lbs.

4. The horse is supposed (doubtless) to walk in the direction in which the rope is stretched; then by principle of virt. vels., the horse pulls (in lbs.) $\frac{1250 \times 18}{150} = 150$.

5. *In accordance with law of fld. press., the press. on bottom* equals wt. of a column of water whose base is 9 sq. in. and ht. 30 in. $= \frac{9 \times 30}{1728} \times 1000$ oz. $= 156\frac{1}{4}$ oz. Press. on table due to water equals wt. of water = wt. of 27 + 27 cub. in. of water $= \frac{54}{1728} \times 1000 = 31\frac{1}{4}$ oz.

6. Let x = ht. of atmosphere in ft.; then press. of air on a sq. ft. $= x \times 1{\cdot}2916$ oz. Also press. of the column of mercury 30 in. high on a sq. ft. $= \frac{30}{12} \times 1000 \times 13{\cdot}596$ oz.; and equilibrium requires these to be equal; $\therefore x = \frac{\frac{30}{12} \times 1000 \times 13{\cdot}596}{1{\cdot}2916} = 26316$ ft.

Mr. Shaw, of Barrington, N.S., has slightly modified his windmill problem (November issue of *Journal*) so as to read as follows: I have a windmill ten feet in diameter with eight blades 3 ft 9 in. at one end and 9 in. at the other, and 4 ft. long. At what angle to the course of the wind must the blades be placed on their arms to have the greatest effect; what will be the power exerted on the cog wheel two feet in diameter; and at what proportion of one horse power could it be rated? The wind is supposed to be blowing at the rate of 15 miles per hour, and then exerting a pressure of one pound to the square foot.

Prof. Galbraith of the School of Practical Science, Toronto, sends the following notes on the problem:

Rankine's formulæ for windmills of the *old style* with sails of the best form is, horse power $= \frac{\cdot 022}{550} \cdot \frac{v^2}{2g}\pi r^2$, where v = vel. of wind in ft. per second, $g = 32{\cdot}2$, $\pi = \frac{22}{7}$, r = radius of wheel in feet. In the present case $v = 22$, $r = 5$, and the horse power of the wheel (allowing for the friction of the axle) if the wheel were of the best design of the old style would be

$$\tfrac{1}{550} \times \frac{\cdot 022 \times 22^3 \times 22 \times 5^2}{2 \times 32{\cdot}2 \times 7} = \cdot 5 \text{ horse power.}$$

The *weather* of the sails, *i.e.*, the inclination of the sail to a plane perpendicular to the axis of the wheel varies from 7° at the tip of the sail to about 19° at the inner end in this wheel. These inclinations were found to give the best effect. So that about 13° would probably be the best weather to give to Mr. Shaw's mill, the sails apparently being flat boards.

It is impossible to say, without actual experiment, what the horse-power of Mr. Shaw's mill would be with a given velocity of wind. The above results are given as having been determined by experiment on wheels of the old design, so that he may judge for himself the comparative efficiency of his wheel.

Rankine gives us a principle of construction that, for a given wind velocity, the weather to be given to any part of the sail must vary with the rate of motion of that part of the wheel, in certain proportions, in order that the wheel may be most effective; and the rule is that (within certain limits) the greater the velocity of *any part of the sail, the less the weather should be—e.g., since the* tip of a wheel must move faster than the centre, the weather at the tip should be less than that at the centre. The whole sail should also have a slightly concave surface.

The above wheel, if of the old style, with sails designed as above, would exert a pressure of about 26 lbs. on the teeth of a bevel wheel 2 feet in diameter, on the shaft of the wheel when transmitting half a horse-power.

Mr. Shaw, of Kemble, sends the following *direct* proof of Prop. 25, Bk. I. *Let ABC, DEF be the two triangles, having BA, AC* equal to *ED, DF* respectively, but the base *BC* greater than *EF*. Place *DEF* so that *E* rests on *B* and *EF* and *BC*, and let the point *D* be on the side of the base away from *A*. Join *AD, DC*. Of the two sides *AB, AC* let *AB* be the one which is not greater than the other. Then the angle *DFB* is not greater than *DBF*; but *DFC* is greater than *DBF*; therefore *DFC* is greater than *DFB*, and much more than *DCF*. Hence *DC* is greater than *DF*, and therefore than *CA*, and the angle *CAD* is greater than *CDA*. Also the angle *BAD* is equal to the angle *BDA*. Therefore the whole angle *BAC* is greater than *BDC* and therefore than *BDF*. If *AD* cuts *CB* produced, the proof will be similar; the angles *BAD, BDA* are then to be taken away.

For Prob. 1, Dec. number, the result is tan (angle of incidence) $= \frac{e^{\frac{3}{2}}}{\sqrt{1 + e + e^2}}$; solution by Mr. Shaw, Kemble.

The answer to Prob. 2 in our last issue is 30[illegible] minutes past 4 o'clock; solution by Mr. Phelps of Woodstock.

The answer to Prob. 3 in our last issue is 19 oxen; arithmetical solution by Mr. Anderson, Mimico; algebraic solutions by Messrs. S. Phelps, Woodstock; L. H. Luck, Crown Hill; and M. L. Nutting, Oshawa.

Problem 3 in Dec. number was, as "Farmer" subsequently informed us, intended to receive a geometrical solution. Mr. Shaw, of Kemble, has sent in a trigonometrical solution, the result being 63·28. Mr. Nutting has inadvertently taken the inscribed circle for the circumscribed.

Mr. Nutting has also sent a correct solution of Prob. 1 in Nov. number.

Want of space prevents us from giving any of the above solutions.

Practical Department.

CONVERSATIONAL COLUMN.

We have received the following lines from Mr. William Anderson, English Master, Toronto Collegiate Institute. They were written *in school* during the composition hour, as an example of anti-climax by one of his pupils:

The silvery moon is sailing in the vault above,
The glimmering stars remote look down with eyes of love,
The breeze that cools my forehead's feverish heat
Is laden with a perfume rare and sweet;
And Philomela's distant Ave Marie,
Comes floating softly o'er the vale to me.
Now would I sleep, nor think on human woes,
Did not the gout with pain distract my toes.

T. M.

As competitive township and county examinations are being held in many parts of the country, we publish below the regulations for the competitive examination held in the township of Beckwith, Dec. 27th, 1878:

1. The Examination will be held in the Town Hall on Friday, Dec. 27th, beginning punctually at 9 o'clock a.m.
2. All pupils resident in the Township, and who have attended at least *eighty days* during the year, are eligible for examination. In the case of union school sections, *Beckwith pupils only* to be admitted.
3. Each Teacher is entitled to present *three* pupils out of each of the *Second, Third, Fourth* and *Fifth* classes. The classes correspond with the Readers.
4. The Examination will be conducted in accordance with the "Official Programme" now in use in the schools.
5. No pupils to be examined in the same classes as at any previous Competitive Examination, and all pupils who have passed the *Entrance Examination to High Schools*, and who are attending any of the Public Schools, *must* be examined in the *Fifth Class*.