4. By selling an article for $21 I would *lose* 12½ %. At what *should I sell it in order to gain* 12½ % ?

5. A merchant marked his goods at an advance of 60 % on cost. He gave one of his customers a discount of 15 % off the marked price. What was his gain on $6.80 received from that customer?

6. How much stock must I sell out of the 3½ per cents., at 84, to enable me to buy $7,700 4 per cent. stock, the value of the stocks being proportional to the dividends they pay?

Values—1, 16 ; 2, 16 ; 3, 17 ; 4. 17 ; 5, 17 ; 6, 17.

SECOND-CLASS TEACHERS—July, 1883.

NATURAL PHILOSOPHY.

TIME—TWO HOURS.

1. Explain what is meant by the statement 'The body A is at rest relative to the body B.' Give illustrations.

If a body in motion be acted upon by three forces in equilibrium, what will be the result with respect to the motion of the body?

2. Explain the geometrical representation of forces.

Two forces acting in lines which meet in a point are represented by the straight lines AB, AC; show that their resultant is represented by 2 AD, where D is the point of bisection of the straight line BC.

Four forces acting in lines which meet in a point are represented by the straight lines AC, BC, AD, BD; show that their resultant is represented by 4 EF, where E and F are the respective points of bisection of the diagonals AB, CD of the quadrilateral $ACBD$.

3. What are the conditions of equilibrium of three forces—

1st, if two of them are parallel to one another ;

2nd, if there are two not parallel to one another ?

A body is pulled N., S., E. and W. by strings whose directions meet in a point, the forces of tension along the strings being equal to 26, 110, 75 and 88 lbs. weight respectively. Show that these forces may be balanced by a force of 85 lbs. weight in the proper direction and by no other single force whatever.

4. What is meant by the moment of a force about a given point? How is the moment of a force about a point measured? State the principle of moments.

A straight pole 12 ft. long and weighing 40 lbs. balances, when unweighted, about a point 5 ft. from one end. When loaded with 2 lbs. at this end and 10 lbs. at the other end, at what point must it be supported in order to balance?

5. Find the relation between the power and the weight in a system of pulleys in which one cord passes round all the pulleys and has its different portions parallel, neglecting friction and the rigidity of the cord, but taking account of the weight of the pulleys.

In such a system what power will sustain a weight (including the lower sheaf of pulleys) of 945 lbs., if the number of cords at the lower block be seven?

6. Four pine planks (specific gravity 48) 16 feet long, 12 inches wide and 2½ inches thick, are bound together to form a raft. Find the greatest load the raft will bear without sinking, granted that a cubic foot of water weighs 1.000 oz.

7. Describe the common pump and explain the principe of its action.

Values—1, 10; 2, 20; 3, 25; 4, 20 ; 5, 15; 6, 10; 7, 10.

EUCLID.

TIME—TWO HOURS.

1. With three given straight lines only one triangle can be formed.

What is the character of the triangle formed by the lines whose lengths are given by $\sqrt{27}$, $\sqrt{48}$ and $\sqrt{125}$?

2. If one side of a triangle be produced the exterior angle is equal to the sum of the two opposite interier angles.

ABC is an isosceles triangle, having the equal angles at B and C. BF and CF are drawn bisecting the angles B and C and intersecting in F.

Show that the angle BFC is equal to the sum of the vertical angle and one of the basal angles.

3. The sum of the interior angles of any rectilineal figure is $2(n-2)$ right angles, where n denotes the number of sides.

Prove this and examine it if be true when the figure has one reëntrant angle.

4. ABC is a triangle, and AD bisects the base BC in D. Show *that the sum of the squares upon the two sides is equal to twice the* square upon half the base, together with twice the square upon the bisecting line.

$KLMN$ is a square, O the point of intersection of its diagonals, and P any point whatever.

$PK^2+PL^2+PM^2+PN^2$ is greater than four times PO^2 by the square upon the diagonal.

5. In any triangle the square upon the side subtending an acute angle is less than the squares upon the sides containing the angle by twice the retangle contained by one of those sides and the line intercepted between the acute angle and the perpendicular let fall upon it from the opposite angle. (Euc. II. 13).

6. In the triangle ABC, the perpendiculars BD and CE from B and C upon the opposite sides intersect in F. Show that the retangle contained by BF and BD is equal to that contained by BE and BA.

7. In Euc. II. 11, find a point H in AB produced so that $AB{\cdot}BH$ is equal to the square upon AH.

Values—1, 10+8 ; 2, 8+8; 3, 8+8 ; 4, 10+10 ; 5, 10 ; 6, 10 ; 7, 10.

ARITHMETIC.

TIME—TWO HOURS.

1. *Prove* that ¼ of $\frac{2}{7}=\frac{2}{7}\frac{3}{8}$.

Simplify

$(2\frac{3}{8}$ of $3\frac{1}{10})+\frac{4}{9}-(1\frac{1}{8}$ of $1\frac{5}{10})-(1\frac{3}{4}$ of $4\frac{1}{7}$ of $\frac{3}{14})$.

2. The pendulum of one clock makes 24 beats in 26″ ; that of another 36 beats in 40″. If they start at the same time, when first will the beats occur together?

3. A can do as much work in 4 hours as B in 6 ; and B in 3½ as C in 5. A does half a certain piece of work in 12 hours ; in what time can it be finished by B and C, working separately equal times, and C succeeding B?

4. A note for $500, made March 9th at three months, is discounted April 11th, at 8 per cent. What is received for the note? (True discount).

5. The unclaimed dividends on a certain amount of stock which pays 6 per cent. per annum amounted in 3 years to $1152. The stock was sold at a discount of 12½ per cent. on its par value. What sum was realized?

6. Teas at 3*s.* 6*d.*, 4*s.* and 6*d.* a pound are mixed to produce a tea worth 5*s.* a pound. What is the least integral number of pounds that the mixture can contain?

7. A man buys 150 lbs. of sugar, and after selling 100 lbs. finds he has been parting with it at a loss of 5 per cent. At what rate per cent. advance on the cost must he sell the remaining 50 lbs. that he may gain 10 per cent. on the entire transaction?

8. Each member of a pedestrian club walks as many miles as there are members in the club, and the expense of the trip is for each member as many pence per mile as there are members in the club. The total expense is £50 13*s.* 11*d.* How many members are there?

9. The hour, minute and second hands of a watch are on concentric axes. When first, after 12 o'clock will the direction of the second hand produced backwards bisect the angle between the hour and the minute hands?

Values—1, 7+6 ; 2, 11 ; 3, 11 ; 4, 10 ; 5, 10 ; 6, 10 ; 7, 11 ; 8, 11 ; 9, 13.

ALGEBRA.

TIME—TWO HOURS.

1. (1). If $x^2-mx+1=0$, express

$\frac{1}{x^2}(x^4-3x^3+2x^2-3x+1)$ as a function of m.

(2). If $x+y=n$, and $xy=n$, express x^3+y^3, and

$\frac{1}{x^3}+\frac{1}{y^3}$ in terms of m and n. $= \frac{4}{m+\sqrt{(m^2-4n)}}$

2. If $cx+sy=\sqrt{a^2c^2+b^2s^2}$,

$-sx+cy=\sqrt{a^2s^2+b^2c^2}$,

and $c^2+s^2=1$,

then $x^2+y^2=a^2+b^2$.