four seconds for example, and the rider can be removed at the end of that time. The other weights keep on moving with a uniform velocity, and it only remains to see what that velocity is by measuring how far they move in a second or a number of seconds. It would be found that if the rider were on the weight for two seconds the velocity would be twice as great as if the rider were acting for only one second, and a number of experiments would show that the velocity was proportional to the length of time the acting force was in operation.

A similiar experiment would show the law regarding the space passed over by the moving system while under the influence of the moving force, the rider.

By using riders of different sizes it would be found that the velocity would depend upon the magnitude of the moving force in comparison with the weight moved. It is to be noted that a rider of four grammes would not give exactly twice the velocity of a rider of two grammes, because in the above instance the two gramme rider moves sixty-two grammes, whereas the four gramme rider would move not sixty-two but sixty-four grammes.

Question 3.—(*a*). What amount of kinetic energy does a body weighing 20 pounds and moving with a velocity of 300 feet per second possess? (*b*). What amount of work can the body do?

The large majority of candidates knew the formula $e = \frac{mv^2}{2}$ but very few that (*a*) and (*b*) are practically the same question, the energy being the measure of the work the body can do.

$$e = \frac{m}{2}v^2 = 10 \times 90{,}000 = 900{,}000.$$

This answer was obtained by many, but here came in the difficulty—900,000 what? Some candidates solved the difficulty by leaving the matter open, probably because they did not realize that they needed to put down the unit, possibly because they thought that was a matter they might leave to the discretion of the examiner. Others knew the term *erg* as applied to work, and gave the answer as 900,000 ergs, forgetting that the erg is the unit of work when mass is measured in grammes and velocity in centimetres per second. Some ventured *pounds*; a few, I think, suggested feet, many gave foot pounds which was the nearest approach to correct, but none, if I remember rightly, gave foot poundals, the correct unit. Foot pounds is a unit of work, in fact the ordinary British unit, but it is not the one applicable here. This can at once be seen by remembering that 900,000 foot pounds would be the work done by 20 pounds falling through 45,000 feet, and a body falling 45,000 feet would have a far greater velocity than 300 feet per second.

In the second part of the question perhaps the greater number used the formula for momentum, but many interpreted the work that the body could do as the power, forgetting that power involves the element of time. In most of these cases 900,000 was divided by 33,000 and the quotient given as horse power. A horse power is the power capable of doing 33,000 *foot pounds* of work per *minute*, and there are half a dozen misconceptions involved in working out (*b*) in this way.

The fourth question on the condensing of steam by ice gave a good deal of trouble; but it would make this article too long were I to go into it fully, and the mere pointing out of the correct solution of the problem would be of little value.

Question 5.—What current will 8 Bunsen cells furnish through an external resistance of 10 ohms? *(a)* When connected in series? *(b)* When connected in arc (assuming each cell to have a resistance of 0.9 ohms and an E. M. F. of 1.8 volts).

This is a formula where the candidate might apply the formula and make his calculation, possibly without understanding the underlying principles. It may be well to make these prominent.

The formula for cells in series is—

$$c = \frac{ne}{nr + R}$$ where n is the number of cells e the electromotive force, and r the resistance of each cell, and R the external resistance. Ohm's Law is a statement of the result of experiments and says that the current is equal to the electro-motive force in the circuit divided by the resistance. Here again the matter of units comes in, but these did not seem to give so much trouble as in the former case. The relation between volts, ohms and amperes is such that when the E. M. F. is measured in volts and the resistance in ohms the quotient of the former, divided by the latter, gives the current in amperes.

When the cells are in series the current goes through them all in succession, hence the resistance of the eight cells in the given example is eight times that of one cell. On the other hand each cell adds its own electromotive force, just as a series of pumps in working would raise water. If one pump raises water twenty-five feet to a reservoir, a second pump could be so placed as to raise it another twenty-five feet, and so with eight similar pumps water could be raised two hundred feet, the quantity of water so raised passing through every one of the pumps and having the friction of the whole series.

In the example given, then, the electromotive force of the eight cells is eight times that of one cell and we see the reason of the formula.

We have therefore

$$c = \frac{8 \times 1.8}{8 \times 0.9 + 10} = \frac{14.4}{17.2} = 0.837 \text{ amperes.}$$

When the cells are in multiple arc, or in parallel, as it is often called, there is no increase of electromotive force. Returning to the analogy of the pumps, it is the same as all the pumps being on the same level. Any number of pumps, each of which was capable of raising water twenty-five feet, could, if they were on the same level, raise water no higher than twenty five feet. If they were all working, water would go through them all and there would be more water raised than with one alone, that is the current of water would be greater, but it would not attain a greater head. In the same way when cells are in parallel a current goes through each of them. The current that goes through each of them depends on the electromotive force of the cell