*Question 5.* Given the dimensions and the slope, with the velocity and discharge of a river in its ordinary state ; re­quired the area or section of the sluice which will raise the waters to a certain height, still allowing the same quantity of water to pass through. Such an operation may render the rivers navigable for small craft or rafts above the sluice.

The problem is reduced to the determination of the size of orifice which will discharge this water with a velocity competent to the height to which the river is to be raised ; only we must take into consideration the velocity of the water above the sluice, considering it as produced by a fall which makes a part of the height productive of the whole velocity at the sluice. Therefore H, in our investigation, must consist of the height to which we mean to raise the waters, and the height which will produce the velocity with which the waters approach the sluice ; *h,* or the depth of the stream, is the ordinary depth of the river. Then (using

*, « , , . . , \*\*\*to h* V,N σ *d*

the former symbols) we have *co— — -■ =*

√2 GS (H — A) Q

√2^G (H—Λ)-

If the area of the sluice is known, and we would learn the height to which it will raise the river, we have\*\*\* H — A = Q2

„ \_ j.ι, for the expression of the rise of the water above 2 G *eeo*

its ordinary level. But from this we must take the height which would produce the velocity of the river ; so that if the sluice were as wide as the river, and were raised to the

\*\*\*Q2

ordinary surface of the water, ~~⅛β~~~~c~~~~^~~.> which expresses the height that produces the velocity under the sluice, must be equal to the depth of thc river, and H—*h* will be = 0.

The performance of aqueduct drains is a very important object, and merits our attention in this place. While the art of managing waters, and of conducting them so as to answer our demands, renders us very important service, by embellishing our habitations, or promoting our commercial intercourse, the art of draining creates as it were new riches, fertilizing tracts of bog or marsh, which were not only useless, but hurtful by their unwholesome exhalations, and converting them into rich pastures and gay meadows. A wild country, occupied by marshes which are inaccessi­ble to herds or flocks, and serve only for the haunts of water-fowls, or the retreat of a few poor fishermen, when • once it is freed from the waters in which it is drowned, opens its lap to receive the most precious seeds, is soon clothed in the richest garb, gives life and abundance to nu­merous herds, and never fails to become the delight of the industrious cultivator who has enfranchised it, and is at­tached to it by the labour which it cost him. In return, it procures him abundance, and supplies him with the means of daily augmenting its fertility. No species of agriculture exhibits such long-continued and progressive improvement. New families flock to the spot, and there multiply ; and there nature seems the more eager to repay their labours, in proportion as she has been obliged, against her will, to keep her treasures locked up for a longer time, chilled by the waters. The countries newly inhabited by the human race, as is a great part of America, especially to the south­ward, are still covered to a great extent with marshes and lakes ; and they would long remain in this condition, if po­pulation, daily making new advances, did not increase in­dustry, by multiplying the cultivating hands, at the same time that it increases their wants. The Author of this beautiful world has at thc beginning formed the great mas­ses of mountain, has scooped out the dales and sloping hills, has traced out the courses, and even formed the beds, of the rivers; but he has left to man the care of making his place of abode, and the field which must feed him, dry

and comfortable. For this task is not beyond his powers, as the others are. Nay, by having this given to him in charge, he is richly repaid for his labour by the very state in which he finds those countries into which he penetrates for the first time. Being covered with lakes and forests, the juices of the soil are kept for him as it were in reserve. The air, the burning heat of the sun, and the continual washing of rains, would have combined to expend and dis­sipate their vegetative powers, had the fields been exposed in the same degree to their action as the inhabited and cul­tivated countries, the most fertile moulds of which are long since lodged in the bottom of the ocean. All this would have been completely lost through the whole extent of South America, had it not been protected by the forests which man must cut down, by the rank herbage which he must burn, and by the marsh and bog which he must de­stroy by draining. Let not ungrateful man complain of this. It is his duty to take on himself the task of opening up treasures, preserved on purpose for him with so much judgment and care. If he has discernment and sensibility, he will even thank the Author of all good, who has thus husbanded them for his use. He will co-operate with his beneficent views, and will be careful not to proceed by wantonly snatching at present any partial good, and by picking out what is most easily procured, regardless of him who is to come afterwards to uncover and extract the re­maining riches of the ground. A wise administration of such a country will think it their duty to leave a just share of this inheritance to their descendants, who are entitled to expect it as the last legatees. National plans of cultivation should be formed on this principle, that the steps taken by the present cultivators for realizing part of the riches of the infant country shall not obstruct the works which will after­wards be necessary for obtaining the remainder. This is carefully attended to in Holland and in China. No man is allowed to conduct the drains, by which he recovers a piece of marsh, in such a way as to render it much more difficult for a neighbour, or even for his own successor, to drain another piece, although it may at present be quite inaccessible. There remain in the middle of the most cul­tivated countries many marshes, which industry has not yet attempted to drain, and where the legislature has not been at pains to prevent many little abuses which have produced elevations in the beds of rivers, and rendered the complete draining of some spots impossible. Administration should attend to such things, because their consequences are great. The sciences and arts, by which alone these difficult and costly jobs can be performed, should be protected, en­couraged, and cherished. It is only from science that we can obtain principles to direct these arts. The problem of draining canals is one of the most important, and yet has hardly ever occupied the attention of the hydraulic specu- latist. We apprehend that the Chevalier du Buat’s theory will throw great light on it ; and regret that the very limited condition of our present work will hardly afford room for a slight sketch of what may be done on the subject. We shall, however, attempt it by a general problem, which will involve most of the chief circumstances which occur in works of that kind.

*Quest.* 6. Let the hollow ground A (fig. 2) be in­undated by rains or springs, and have no outlet but the canal AB, by which it discharges its water into the neighbouring river BCDE, and let its surface be nearly on a level with that of the river at B. It can only drain when the river sinke in the droughts of summer ; and even if it could then drain completely, the