is over, the little fish can be returned unharmed to the aquarium, to be forever afterwards an object of intelligent admiration by the pupils, and there is no impression of cruelty and hard-heartedness on their minds, the impression that is the strongest when a pithed or chloroformed frog is used.

The picture obtained by the use of small, or even quite full grown tadpoles is nearly as striking. These can be laid flat on the slide and held in place by a little cage of wood or plaster of paris. But a method that always creates the deepest impression is the demonstration of the circulatory system in the chick embryo of from 36 to 72 hours. These can be obtained by incubating fresh eggs in the laboratory or by the use of hens. The eggs should be opened under warm, physiological saline (0.7 per cent NaCl 37.5° C.; pure water, of course, kills the embryo), and observed by the class. With a pair of fine dissecting shears the germinal disc can then be removed and floated out in a watch glass. Under the dissecting microscope and the low power of the compound microscope, the entire circulatory system can be studied. The action of the heart and the flow of the blood can be seen with perfect distinctness, and in a way that creates the most vivid impression, and one that can hardly be obtained by any other method.

These observations, coupled with experiments with the syringe-bulb model and a study of the anatomy of the sheep's heart, give a clear idea of the circulatory system, with no recourse to what the laity will always rightly consider cruel and heartless methods.

BALANCE DETAILS.

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The following plan for a balance of any desired sensitiveness and accuracy, and yet of a construction involving no very difficult operations and but little expenditure for material and tools, is offered as a suggestion to teachers who may not be able to buy quite as good balances of the conventional kind as they may need.

The chief object in designing the balance was to eliminate knife edges, especially for supporting the pans, and to substitute something equally good for most work. Incidentally several other details in construction were simplified and brought within the powers of the man handy with ordinary tools.

The plan as drawn is taken from a balance in actual use, with but few changes in some minor details. The pointer is omitted

for the sake of clearness. The size of each part may be deduced from the length of the beam, 8 1-2 inches between pan supports. The beam is of 1-16 inch sheet aluminum, the pans and hangings from very thin aluminum sheet and wire. The remaining parts are all of brass, with the exception of the fiber base and the bearings for the beam and pans. Parts r , r' , r'' , r''' and r'''' are brass rods and tubes, $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ inch in diameter. Parts S' , S'' , S''' , S'''' , p , l , etc., are of sheet brass $\frac{1}{8}$, 1-16th and 1-32nd inch

in thickness. The standard, r'' , is soldered to the base plate, S''' . The bent plate, S' , which carries what corresponds to the agate planes in the conventional construction, is soldered to the lift and guide rods, r' and r''' . The bent plate, S'' , is soldered to one of the plates S''' . S'' and S''' receive the beam in four V-notches when it is lowered to change the weights. The mechanism below the base needs no explanation.

Taking up now the special features, the beam bearings and the pan supports, Fig. 1 gives a top view of the right hand pan support. Pinched between the plates l and m is a silk fiber or collection of fibers, f , and these fasten to the wires that support the pan. At one end the beam is slotted longitudinally so as to allow l to be adjusted to bring the points of flexure of the fibers equally distant from the beam bearings.

Fig. 2 gives a bottom view of the beam bearings and the parts of the lift in immediate contact therewith. n' and n'' are very fine cambric sewing needles. n' is soldered to the rod r , which rod is soldered to the plate p and fastened to the beam as shown. The needles, n'' , are fastened to the edges of the U-shaped plate, S' , and extend at right angles to n' . The radius of n' being very small, ordinary deflections do not change the relative lengths of arms of the balance appreciably.

The rolling friction between the supporting needles is so small and the resistance of the silk fibers to flexure is so slight, that the sensitiveness of the balance compares favorably with that of those having agate planes and knife edges. In ease of construction, adjustment and repair, and in stability in use, the knife edge construction is considerably exceeded. The balance from which the plan was drawn will easily give a deflection of two millimeters per milligram, and will carry a load of 200 grams.

Balances are in use constructed after the same general plans, but with the following modifications:

(1) One balance of six-inch beam and of a much lighter construction shows a deflection of ten millimeters for one milligram difference in load, and easily carries 50 grams in each pan. This balance represents a much more carefully made design than the first and is, of course, inclosed in a case.

(2) On the other hand, balances have been used with considerable satisfaction whose beams were of a close-grained wood, whose beam bearings were fastened to the top of wooden pillars, with no lifting mechanism, whose pan supports were held between L-shaped brass paper fasteners secured to the beam by wood screws, whose needles were about No. 3 in size; and yet they had a sensitiveness of 0.01 gram and a carrying capacity of $\frac{1}{2}$ kilo in each pan, combined with a practicability and a minimum of cost that meant much when equipment was deficient.

These balances, and other pieces of apparatus involving the same kinds of bearings of crossed cylinders and flexible suspensions of fibers bending where they are pinched in a crack, have been in use now for nearly ten years, and have proved more than satisfactory, considering the ease with which they have been made, their stability in action, and the sensitiveness and accuracy of which they are susceptible.

A SPECTROMETER.

BY JOHN LE MAY,

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A spectrometer suitable for the laboratory work of most secondary schools may be constructed without excessive expenditure of either money or labor.

A circular table *A* of seven-eighths inch wood ten inches in diameter is fitted closely to a one inch brass tube seven and a half inches long. It is fixed in place by roughening the brass tube and gluing. A circular block *B* is used to make the support firmer. A six inch circle of wood *C* serves as a base. The whole is rendered more stable by filling the lower half of the tube with Babbitt or other expansive metal. The Babbitt metal should be cast into the tube before the wood parts are fitted on.

The rotating table *D* is a three inch circle of wood one half inch thick, with a one inch hole three-eighths of an inch deep on the under side, to fit over the top of the brass tube. A pointer *E*