them in the course, and which will give him the ability to understand such processes as photosynthesis, respiration, transpiration and digestion. It is hard to conceive how a pupil who has merely read about chloroplasts in a book can form much of an idea of carbon assimilation from such sources. He may be able to recite all about it, but that does not argue that he understands it. In beginning with the microscope, the teacher devotes some time to "showing off" the instrument by the use of various attractive mounts. Some of the things that have kept the attention of the pupil concentrated upon the work are diatoms, pleurococcus and other algae, starch grains, cells of a potato or apple, blood corpuscles, various infusoria, scales from a butterfly's wing, etc. A visitor going into this laboratory and finding the pupils interested in the antics of the paramœcium might insist that the study was not botany, but that only shows how very little he knows about it.

C. N. W.

BALANCED SEA-WATER AQUARIA.

BY L. B. SPENCER,

New York Aquarium.

EDITORIAL NOTE.—For several years the New York Aquarium has kept many high schools and some elementary schools of New York City supplied with balanced sea-water aquaria. We have prevailed on Mr. Spencer, who has had charge of this work at the aquarium, to tell the readers of SCHOOL SCIENCE AND MATHEMATICS what a school aquarium may contain and how it should be cared for. If any of our readers have had experience in shipping live sea animals inland, we should be glad to hear from them.

A five gallon round glass aquarium is the kind and size used in the schools of all the boroughs of New York City. The aquarium jar should be placed in a window, or so near one that it will get strong light. If the sunlight strikes it, place a screen between it and the window. Do not pull down the shade, for the aquarium requires actinic light, but not direct sunlight, unless the water becomes cloudy. If that happens direct sunlight for a short time will help it. Cover the bottom with a layer of coarse, clean beach gravel, place on it a flat piece of rock about three by four inches square and about one inch thick on the room side of the aquarium, one inch from the glass. Put in the sea water, filling the jar up to the bend on the top edge. Place two brown sea anemones (*Metridium marginatum*) or five or six of

the *Sagartia* genus on the piece of stone. Put in five or six fairy shrimps (*Palaemonetes vulgaris*); three to five sheepshead lebia, (*Cyprinodon variegatus*), a beautiful little aquarium fish. If these are not to be had, use the more common salt water killie fish (*Fundulus heteroclitus*). The snail (*Nassa obsoleta*) is interesting to watch, and is a scavenger. The hard clam (*Venus mercenaria*), the soft clam (*Mya arenaria*), the oyster (*Ostrea virginica*) can be used, if their valves are open, it is well to touch them with the feeding stick once a day. If they are all right, the valves will be closed at once; if not, take the sick or dead one out promptly, or the water will be spoiled by the decomposition of the mollusk. The acorn barnacle (*Balanus balanoides*) usually does well for a time. The sea lettuce (*Ulva latissima*) is the only practical plant to supply oxygen for a marine aquarium. Use pieces of cork about one inch square by one quarter of an inch thick, under each sheet of *Ulva* to keep it at the top of the aquarium. Use five or six sheets of the lettuce ten or twelve inches in diameter. Do not let the *Ulva* sink to the bottom. Once a week make up for evaporation by pouring fresh water into the aquarium.

Feed the animal life three times a week, with very small pieces of the soft part of the hard clam or oyster. The fishes and shrimps will take the pieces as they float towards the bottom. Put a small piece of the food on the end of the feeding stick, and place it among the tentacles of the anemones, as they cannot reach out for dead food. Be extremely careful not to put in more food than the animals will eat. If any pieces of food are not eaten they must be removed a few hours after feeding to prevent trouble from decay. For this purpose use a glass tube with a half inch hole, length about eighteen inches. Place the thumb tightly on top of the tube, put the open end into the water to the bottom among the pebbles, raise the thumb slightly to let the air escape, and the water and pieces of food will instantly rise in the tube. Press the thumb at once tightly on top of the tube, raise it out of the aquarium, hold the lower end in a small scrim net, held with the left hand over the aquarium. Raise the thumb and the water will run out. The net will retain any solid substance. If proper care is exercised the balance can be maintained for years. A balanced aquarium in the laboratory of the New York Aquarium was filled with sea water and stocked by the writer fifteen years ago last June, and the water has not been changed.

If from any cause the water becomes cloudy, take a tin or glass vessel, dip up some of the water, hold the vessel eight or ten inches above the aquarium, and pour the water back. The stream of water catches up oxygen and carries it into the aquarium. Repeat this operation two or three times a day until the water clears up. Once or twice a year it will probably be best to clean the gravel. In doing this, remove the fishes and shrimps with the small net, then carefully siphon out the water; within about an inch of the bottom, remove the *Ulva*, take out all of the animal life, which with the fishes and shrimp can be put into the water taken from the aquarium. Then strain the inch of water, wash the gravel and the inside of aquarium; put back gravel, water, animal life and *Ulva*, and the aquarium should be all right, with proper care, for many months.

THE CULTURE AIM IN PHYSICS TEACHING.¹

BY FRANK B. SPAULDING,

Boys' High School, Brooklyn.

No two persons mean precisely the same thing by culture. A scholarly recluse and a leader of polite society, after a vain attempt at conversation, may be expected to vote each other wholly devoid of culture. In fact, each represents a high degree of cultivation in a particular form of intelligence. Matthew Arnold, in the preface to "Literature and Dogma," defines culture as "the acquainting ourselves with the best that has been known and said in the world, and thus with the history of the human spirit." But the human spirit is not always the literary and speculative spirit of Matthew Arnold. Let us take a definition more modern in tone furnished by W. H. Brooks, who says, "Culture consists of acquaintance with all the old and new results of intellectual activity in all departments of knowledge, so far as they conduce to welfare, to correct living and to rational conduct." Physics is a department of knowledge which can offer to the student results of both old and new intellectual activity conducing in a very direct and important way to human welfare and rational conduct. However small a part such knowledge may have played in the development of ancient and mediæval minds, no culture is entitled to be called

¹Read before the joint meeting of the Physics Club of New York and the New England Association of Physics Teachers, at Hartford, Conn., April 24th, 1909.