

**A CALENDAR OF
LEADING
EXPERIMENTS**

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A calendar of leading experiments by Wm. S. Franklin & Barry MacNutt

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WM. S. FRANKLIN & BARRY MACNUTT

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Bacon long ago listed in his quaint way the things which seemed to him most needful for the advancement of learning, and among other things he mentioned A Calendar of Leading Experiments for the better Interpretation of Nature.

A CALENDAR OF LEADING EXPERIMENTS

BY

WM. S. FRANKLIN AND BARRY MACNUTT

UNIV. OF
CALIFORNIA

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PREFACE.

(a) "A boatman sits on a seat, braces his feet against a cleat and pulls on an oar. What forces act on the boatman's body?" The earth pulls on the boatman, the seat pushes on the boatman, the cleat pushes on the boatman and the oar pulls on the boatman. This is all very simple to one who has acquired the habit of analytical thinking, but a large group of sophomore engineering students got an average of 45 per cent in their answers to the question after two weeks of insistent coaching on *the fundamental notion of force action*, and nearly every human aspect of boating was represented in the answers, including even the chance of a ducking, for several of the young men would have it that the *water* pushes on the boatman's body.

(b) Ask a student of elementary mechanics *how a body (a particle) behaves when it is acted upon by an unbalanced force*, and the natural habit of thinking-in-terms-of-human-values shows itself after the most exacting class-room drill. Instead of giving his attention narrowly to *what is taking place at an instant*, the student, in his groping for human values (which do not exist in the bare elements of a subject), is pretty sure to refer to past history and to future prospects; his idea as to what *is taking place* is apt to remain widely inclusive, as if he were thinking of a complex human experience like two hours at a play, or a month's vacation, or four years of war. Very often the homely wording of the question as stated above betrays the student into a disclosure of his native contempt for precise ideas and he answers naively that "the body moves in the direction of the force." It is very difficult to develop the habit of analytical thinking.

Our teachers of mathematics seem to know that they are responsible for a certain kind of training, and they are not ashamed to apply themselves narrowly in its accomplishment.

Indeed, many of us *who do not share their responsibility* are inclined to think that mathematics teachers apply themselves too narrowly, because their students, as we get them, are deficient in mathematical ideas although strong, it maybe, on forms.

Physics teachers also have a definite responsibility, and our notion as to this responsibility is suggested by examples *a* and *b* above. The physics teacher, however, is strongly imbued with the idea that his function is to disclose to the student his (the physicist's) "domain of nature," and he is inclined therefore to discuss results—Helmholtz's theory of the origin of the sun's heat, Lord Kelvin's calculations of the age of the earth, and many other things of equal speculative interest—but such things prematurely considered divert the student's attention away from elementary or irreducible ideas and conceptions without which no analytical thinking is possible.

Results are fine inventions
For gentlemen who see;
But the micro-scope is needed
In this emergency.

Primarily this book has to do with class-room experiments in physics. The best experiments are those that are homely and simple, and suggestive rather than informing. The physics lecturer should pull ideas out of things like a prestidigitateur, and many of his demonstrations should be mere motion experiments,* by which we do not mean experiments which have to do with the theory of motion! We do not believe in the lecture experiment which aims at a numerical result rather than at an idea,—decidedly we do not; and our pet aversion is the "study in still life," if we may so describe the deadly lantern slide. Imagine a sleight-of-hand performer making use of lantern slides! It is unthinkable, and yet there never was a sleight-of-hand performer who had one tenth of the resources of the physics lecturer in college. In a two-years' course in elementary physics

* See pages 51 and 82 for examples.

we use, by actual count, 31 lantern slides; and out of a total of 48 lecture periods in the two years' course we have always used 8 or more for written tests on text-book and recitation work. This may seem to some as a damning confession, but the constraint which leads to analytical thinking cannot be made to operate through any combination of talk and show. No Missourian was ever regenerated by talk; and even when you have shown him he remains what he was before—a Missourian.

Secondarily this book is intended to set forth the possibilities of an extended course in elementary dynamics, including the dynamics of wave motion.

Some things in this book may seem to call for apology, for we simply cannot refrain from an occasional diversion in the way of poking fun, because so many things in teaching *are* funny, from our point of view.

From our point of view. Let no one who reads this book lose sight of the qualification. We might, of course, have dwelt here and there on faults of our own, but such things are not funny—from our point of view. For example, we have many times caught ourselves mistaking the fixity of an idea for its *raison d'être*, whereas the fixity of an idea is not the same thing as reason, especially when it comes to making the idea clear to a young student. Also we have many times been victims of the "illusion of activity" by which we mean the sense of one's effectiveness which comes from being wholly engaged in an undertaking. "The lecture we gave this morning; how complete and perfect it was; what a masterpiece of edification!" The only cure for this illusion is the reaction of the students, and no teacher who seeks and uses this cure can be proud of his work; although he may develop a humble but invincible self-respect in that he never fails to do his best.

W. S. FRANKLIN,
BARRY MACNUTT,

October 27, 1917.

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