by curves of types *b* and *c*. This type of curve indicates that practically no effect is produced until the dosage reaches a certain value, after which the number of cells affected increases rapidly (*i.e.*, the percentage survival decreases rapidly), and a few cells always survive much larger doses than the average.

In 1926 Professor Crowther made the very logical and fruitful suggestion that more than one hit may be necessary to put the sensitive organ of the cell out of action ; and working on the theory of probability he deduced a mathematical expression for the number of particles which have been hit less than n times, and thus calculated the number of survivors if n hits are required to put the particles out of action. The expression takes the form

$$S=N\left\{1+\frac{\lambda q}{\underline{|1}}+\frac{(\lambda q)^2}{\underline{|2}}+\ldots\ldots\frac{(\lambda q)^{n-1}}{\underline{|n-1}}\right\}e^{-\lambda q}$$

and connects the number of survivors S with the total number of irradiated cells N, the chance of one hit λ, the number n of hits required to put the particle out of action, and q the dose of X-rays.

Experiments were made on a pure culture of the protozoan *Colpidium colpoda*, and it was found that this organism requires a succession of forty-nine hits on some particular structure before it is killed by X-rays.

It will now be seen that the above relation reduces to the simple exponential

$$S=Ne^{-\lambda q}$$

when only one hit is required to put the organ out of action. It is clearly a special case of the more general equation.

The significance of survival curves has been considered by other authors, particularly by Packard, and the view that the living cell contains a sensitive zone is not universally accepted. It seems, then, an alternative interpretation may be possible, but whatever the ultimate result may be, it is certain that the survival curve is represented by the general equation given above, and this equation has formed the starting point of many important researches and provides the basis of modern quantitative radio-biology.

A LEVEL SURFACE.

PORTION of a question in the last (1933) Intermediate Certificate Examination in Physics (N.S.W.) called for the definition of "a level surface", and apparently some Science teachers in schools have been perturbed because their mathematical colleagues regard a level surface as necessarily being a plane. Authorities, such as Routh in his "Analytical Statics" (Vol. II, page 23, 2nd Edition), specifically give a definition of the form:

"Level Surfaces. The locus of points at which the potential has any one given value is called a level surface. It is also called *an equipotential surface.*

"At any point of a level surface the resultant acts along the normal to the surface."

". . . Level surfaces are therefore also called surfaces of equilibrium."

With reference to the gravitational field of the Earth, distinction must be made between a plane surface, a horizontal plane surface, and a level surface. Over a *sufficiently small area,* a level surface *approximates* to a horizontal plane, because the verticals from all points in it are approximately parallel. Loney, in his "Statics" (1912), page 355, says: "The Equipotential Surfaces are often called level surfaces, or *surfaces de niveau,* from an analogy with the Earth. If we consider gravity constant, the equipotential surface at any *point* of the Earth's surface is a horizontal plane, or rather a portion of a very large sphere concentric with the Earth."

MAGNETS AND MAGNETISM.

By Edgar Booth.

Most people think of magnets as toys with which children play for a few hours before discarding them for some other novelty, and magnetism as a subject of mathematical interest to scholars, but of no importance in everyday affairs; but all the electrical energy which is used commercially and in the household depends upon the existence of magnets, and its safe and continuous supply depends upon the proper operation of powerful electromagnets; the design of the elaborate and expensive equipment for the production of electricity necessitates, therefore, a sound knowledge of the subject of magnetism. Until the underlying relationships between magnetism and electricity were first shown by