arrangement is not arbitrary. The first selection is the shortened form of the notorious modern statement by C. P. Snow, who has been at the center of the controversy for at least a decade. This is followed by a careful definition of science by a humanist scientifically inclined, and this, in turn, by three pieces from past centuries which raise many of the modern problems. At the heart of the book are set—in essays by Matthew Arnold and T. H. Huxley—the classic nineteenth-century formulations of the problem as it relates to education. These are followed by Lionel Trilling's examination both of the nineteenth-century debate and of the contemporary, acrimonious debate between F. R. Leavis and Snow. Next, there are biographical sketches of a scientist, Charles Darwin, and of a humanist, William Butler Yeats, two men whose very lives suggest the nature of the conflict. There follow, after Whitman's famous poem dramatizing the romantic reaction to science, several recent works—one an extremely intelligent and amusing science-fiction story—which suggest how various writers and scientists have attempted to work out the problems to their personal satisfaction. The essays by Robert Oppenheimer and Howard Mumford Jones indicate the difficulty of making intelligible to the layman the problems of their divergent disciplines. At the conclusion is a forceful and complex statement of the possibilities of reconciliation between the two modes of knowledge. The bibliography, though necessarily very incomplete, offers a relatively wide variety of material for further reading.

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G. L.
O. T.

Bloomington, Indiana
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THE TWO CULTURES

C. P. Snow

"It's rather odd," said G. H. Hardy, one afternoon in the early Thirties, "but when we hear about 'intellectuals' nowadays, it doesn't include people like me and J. J. Thomson and Rutherford." Hardy was the first mathematician of his generation, J. J. Thomson the first physicist of his; as for Rutherford, he was one of the greatest scientists who have ever lived. Some bright young literary person (I forget the exact context) putting them outside the enclosure reserved for intellectuals seemed to Hardy the best joke for some time. It does not seem quite such a good joke now. The separation between the two cultures has been getting deeper under our eyes; there is now precious little communication between them, little but different kinds of incomprehension and dislike.

The traditional culture, which is, of course, mainly literary, is behaving like a state whose power is rapidly declining—standing on its precarious dignity, spending far too much energy on Alexandrian intricacies, occasionally letting fly in fits of aggressive pique quite beyond its means, too much on the defensive to show any generous imagination to the forces which must inevitably reshape it. Whereas the scientific culture is expansive, not restrictive, confident at the roots, the more confident after its bout of Oppenheimerian self-criticism, certain that history is on its side, impatient, intolerant, creative rather than critical, good-natured and brash. Neither culture knows the virtues of the other; often it seems they deliberately do not want to know. The resentment which the traditional culture feels for the scientific is shaded with fear; from the

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other side, the resentment is not shaded so much as brimming with irritation. When scientists are faced with an expression of the traditional culture, it tends (to borrow Mr. William Cooper's eloquent phrase) to make their feet ache.

It does not need saying that generalisations of this kind are bound to look silly at the edges. There are a good many scientists indistinguishable from literary persons, and vice versa. Even the stereotype generalisations about scientists are misleading without some sort of detail—*e.g.*, the generalisation that scientists as a group stand on the political Left. This is only partly true. A very high proportion of engineers is almost as conservative as doctors; of pure scientists, the same would apply to chemists. It is only among physicists and biologists that one finds the Left in strength. If one compared the whole body of scientists with their opposite numbers of the traditional culture (writers, academics, and so on), the total result might be a few per cent. more towards the Left wing, but not more than that. Nevertheless, as a first approximation, the scientific culture is real enough, and so is its difference from the traditional. For anyone like myself, by education a scientist, by calling a writer, at one time moving between groups of scientists and writers in the same evening, the difference has seemed dramatic.

The first thing, impossible to miss, is that scientists are on the up and up; they have the strength of a social force behind them. If they are English, they share the experience common to us all—of being in a country sliding economically downhill —but in addition (and to many of them it seems psychologically more important) they belong to something more than a profession, to something more like a directing class of a new society. In a sense oddly divorced from politics, they are the new men. Even the staidest and most politically conservative of scientific veterans, lurking in dignity in their colleges, have some kind of link with the world to come. They do not hate it as their colleagues do; part of their mind is open to it; almost against their will, there is a residual glimmer of kinship there. The young English scientists may and do curse their luck; increasingly they fret about the rigidities of their universities, about the ossification of the traditional culture which,

to the scientists, makes the universities cold and dead; they violently envy their Russian counterparts who have money and equipment without discernible limit, who have the whole field wide open. But still they stay pretty resilient: they are swept on by the same social force. Harwell and Winscale have just as much spirit as Los Alamos and Chalk River: the neat petty bourgeois houses, the tough and clever young, the crowds of children: they are symbols, frontier towns.

There is a touch of the frontier qualities, in fact, about the whole scientific culture. Its tone is, for example, steadily heterosexual. The difference in social manners between Harwell and Hampstead, or as far as that goes between Los Alamos and Greenwich Village, would make an anthropologist blink. About the whole scientific culture, there is an absence —surprising to outsiders—of the feline and oblique. Sometimes it seems that scientists relish speaking the truth, especially when it is unpleasant. The climate of personal relations is singularly bracing, not to say harsh: it strikes bleakly on those unused to it, who suddenly find that the scientists' way of deciding on action is by a full-dress argument, with no regard for sensibilities and no holds barred. No body of people ever believed more in dialectic as the primary method of attaining sense; and if you want a picture of scientists in their off-moments it could be just one of a knock-about argument. Under the argument there glitter egotisms as rapacious as any of ours: but, unlike ours, the egotisms are driven by a common purpose.

How much of the traditional culture gets through to them? The answer is not simple. A good many scientists, including some of the most gifted, have the tastes of literary persons, read the same things, and read as much. Broadly, though, the infiltration is much less. History gets across to a certain extent, in particular social history: the sheer mechanics of living, how men ate, built, travelled, worked, touches a good many scientific imaginations, so they have fastened on such works as Trevelyan's *Social History*, and Professor Gordon Childe's books. Philosophy, the scientific culture views with indifference, especially metaphysics. As Rutherford said cheerfully to Samuel Alexander: "When you think of all the years you've been talk-

ing about those things, Alexander, and what does it all add up to? *Hot air*, nothing but *hot air*." A bit less exuberantly, that is what contemporary scientists would say. They regard it as a major intellectual virtue, to know what not to think about. They might touch their hats to linguistic analysis, as a relatively honourable way of wasting time; not so to existentialism.

The arts? The only one which is cultivated among scientists is music. It goes both wide and deep; there may possibly be a greater density of musical appreciation than in the traditional culture. In comparison, the graphic arts (except architecture) score little, and poetry not at all. Some novels work their way through, but not as a rule the novels which literary persons set most value on. The two cultures have so few points of contact that the diffusion of novels shows the same sort of delay, and exhibits the same oddities, as though they were getting into translation in a foreign country. It is only fairly recently, for instance, that Graham Greene and Evelyn Waugh have become more than names. And, just as it is rather startling to find that in Italy Bruce Marshall is by a long shot the best-known British novelist, so it jolts one to hear scientists talking with attention of the works of Nevil Shute. In fact, there is a good reason for that: Mr. Shute was himself a high-class engineer, and a book like *No Highway* is packed with technical stuff that is not only accurate but often original. Incidentally, there are benefits to be gained from listening to intelligent men, utterly removed from the literary scene and unconcerned as to who's in and who's out. One can pick up such a comment as a scientist once made, that it looked to him as though the current preoccupations of the New Criticism, the extreme concentration on a tiny passage, had made us curiously insensitive to the total flavour of a work, to its cumulative effects, to the epic qualities in literature. But, on the other side of the coin, one is just as likely to listen to three of the most massive intellects in Europe happily discussing the merits of *The Wallet of Kai-Lung*.

When you meet the younger rank-and-file of scientists, it often seems that they do not read at all. The prestige of the traditional culture is high enough for some of them to make

a gallant shot at it. Oddly enough, the novelist whose name to them has become a token of esoteric literary excellence is that difficult highbrow Dickens. They approach him in a grim and dutiful spirit as though tackling *Finnegan's Wake*, and feel a sense of achievement if they manage to read a book through. But most young technicians do not fly so high. When you ask them what they read—"As a married man," one says, "I prefer the garden." Another says: "I always like just to use my books as tools." (Difficult to resist speculating what kind of tool a book would make. A sort of hammer? A crude digging instrument?)

That, or something like it, is a measure of the incommunicability of the two cultures. On their side the scientists are losing a great deal. Some of that loss is inevitable: it must and would happen in any society at our technical level. But in this country we make it quite unnecessarily worse by our educational patterns. On the other side, how much does the traditional culture lose by the separation?

I am inclined to think, even more. Not only practically—we are familiar with those arguments by now—but also intellectually and morally. The intellectual loss is a little difficult to appraise. Most scientists would claim that you cannot comprehend the world unless you know the structure of science, in particular of physical science. In a sense, and a perfectly genuine sense, that is true. Not to have read *War and Peace* and *La Cousine Bette* and *La Chartreuse de Parme* is not to be educated; but so is not to have a glimmer of the Second Law of Thermodynamics. Yet that case ought not to be pressed too far. It is more justifiable to say that those without any scientific understanding miss a whole body of experience: they are rather like the tone deaf, from whom all musical experience is cut off and who have to get on without it. The intellectual invasions of science are, however, penetrating deeper. Psycho-analysis once looked like a deep invasion, but that was a false alarm; cybernetics may turn out to be the real thing, driving down into the problems of will and cause and motive. If so, those who do not understand the method will not understand the depths of their own cultures.

But the greatest enrichment the scientific culture could give

us is—though it does not originate like that—a moral one. Among scientists, deep-natured men know, as starkly as any men have known, that the individual human condition is tragic; for all its triumphs and joys, the essence of it is loneliness and the end death. But what they will not admit is that, because the individual condition is tragic, therefore the social condition must be tragic, too. Because a man must die, that is no excuse for his dying before his time and after a servile life. The impulse behind the scientists drives them to limit the area of tragedy, to take nothing as tragic that can conceivably lie within men's will. They have nothing but contempt for those representatives of the traditional culture who use a deep insight into man's fate to obscure the social truth—or to do something pettier than obscure the truth, just to hang on to a few perks. Dostoevski sucking up to the Chancellor Pobedonostsev, who thought the only thing wrong with slavery was that there was not enough of it; the political decadence of the *avant garde* of 1914, with Ezra Pound finishing up broadcasting for the Fascists; Claudel agreeing sanctimoniously with the Marshal about the virtue in others' suffering; Faulkner giving sentimental reasons for treating Negroes as a different species. They are all symptoms of the deepest temptation of the clerks—which is to say: "Because man's condition is tragic, everyone ought to stay in their place, with mine as it happens somewhere near the top." From that particular temptation, made up of defeat, self-indulgence, and moral vanity, the scientific culture is almost totally immune. It is that kind of moral health of the scientists which, in the last few years, the rest of us have needed most; and of which, because the two cultures scarcely touch, we have been most deprived.

WHAT SCIENCE IS

H. J. Muller

Roughly stated, the scintific method is to go and look, and then look again. The most elaborate experiments and abstruse equations are designed o answer the simple question, "What are the facts?" Today his question seems so natural and obviously sensible that it i hard to understand how for centuries men could repeat Plinys statement, that the blood of a goat would shatter a diamon, when a simple test would have disproved it. Yet it seems that they did not perform the test; and the explanation is hat the basis of their thought was not empirical but "rational' Although Aristotle went to nature, he returned for authority to pure reason. He simply asserted that heavy bodies mustfall faster than light ones, just as he asserted that planets move in circles because the circle is the only perfect figure. Here Galileo's Pisa experiment marked a real revolution in thought. It marked, Dewey summarizes:

> a change from the qualitative to the quantitative or metric; from the heterogeneous to thehomogeneous; from intrinsic form to relations; from esthetic harmonies to mathematical formulae; from contemplative enjoyment to active manipulation and control; from rest to change; from eternal objects to temporal sequence.

In this summary, science already begins to look strange to the plain man; and ofcourse it is strange. Even as roughly stated, its method is till not generally applied to moral, political, or other problems. For science is not, strictly, "organized common sense' Common sense is not only much vaguer and more cocksure but in a way, curiously, more practical. It deals with the total concrete situation, takes life as it comes. Science always abstracts for a very limited purpose, makes up fictions. Especially in late years, it has left common

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