Why Did Benjamin Franklin Fly the Kite?

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Shuffle across a nylon rug on a dry winter day and your body acquires an excess electrical charge. That charge may be violently released by a spark jumping from your finger tip to a light switch or doorknob. Lightning is nothing more than a very long spark which discharges regions of excess electrical charge developed in thunderclouds. Frictional charging, that is charging by rubbing together certain dissimilar materials such as a shoe sole and the rug, has probably always been familiar to man. In 1746 Benjamin Franklin began his experiments in electricity. His experiments were made possible by (1) the frictional charging

mechanism and (2) the fortuitous invention earlier that year of the Leyden jar — a primitive capacitor to store electrical charge.

Prior to Franklin's interest with electricity, a number of scientists had suggested that lightning might be an electrical phenomenon. Their concern, however, had gone no further than suggestion. In November 1749 Franklin wrote the following about the sparks (in his terminology, electrical fluid) he had studied.

> Electrical fluid agrees with lightning in these particulars. 1. Giving light. 2. Colour of the light. 3. Crooked direction. 4. Swift motion. 5. Being conducted by metals. 6. Crack or noise in exploding. 7. Subsisting in water or ice. 8. Rending bodies as it passes through. 9. Destroying animals. 10. Melting metals. 11. Firing inflammable substances. 12. Sulphureous smell. The electrical fluid is attracted by points. We do not know whether this property is in lightning. But since they agree in all particulars wherein we can already compare them, is it not possible they agree likewise in this? Let the experiment be made. (Ref. 1.1)

Franklin was the first to design an experiment to prove that lightning was electrical. In July 1750 he wrote:

> To determine the question whether the clouds that contain lightning are electrified or not, I would propose an experiment to be tried where it may be done conveniently. On the top of some high tower or steeple place a kind of sentry box . . . big enough to contain a man and an electrical stand [an insulator]. From the middle of the stand let an iron rod rise and pass bending out of the door, and then upright twenty or thirty feet, pointed very sharp at the end. If the electrical stand be kept clean and dry, a man standing on it when such clouds are passing low might be electrified and afford sparks, the rod drawing fire to him from the cloud. If any danger to the man should be apprehended (though I think there would be none), let him stand on the floor of his box and now and then bring near to the rod the

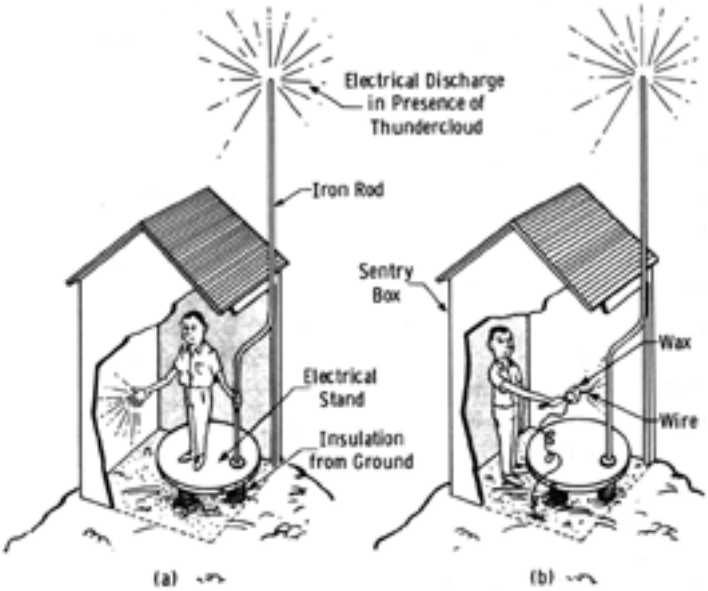

Figure 1.1: Franklin's original experiment to show that thunderclouds are electrified. (a) Man on electrical stand holds iron rod with one hand and obtains an electrical discharge between the other hand and ground. (b) Man on ground draws sparks between iron rod and a grounded wire held by an insulating wax handle.

> loop of a wire that has one end fastened to the leads, he holding it by a wax handle; so the sparks, if the rod is electrified, will strike from the rod to the wire and not affect him. (Ref. 1.2)

His experiment and the results he expected to achieve are illustrated in Fig. 1.1. The aim was to show that the clouds were electrically charged, for if this were the case, it followed that lightning was also electrical. Franklin did not appreciate the danger involved in his experiment. If the iron rod were directly struck by lightning, the experimenter would almost certainly be killed. Such was eventually to be the case as we shall see.

In France in May 1752 Thomas-Francois D'Alibard successfully performed Franklin's suggested experiment. Sparks were observed to jump from the iron rod during a thunderstorm. It

was proved that thunderclouds contain electrical charge. Soon after, the experiment was successfully repeated in France again, in England, and in Belgium. In July 1753 G. W. Richmann, a Swedish physicist working in Russia, put up an experimental rod and was killed by a direct lightning strike.

Before Franklin himself got around to performing the experiment, he thought of a better way of proving his theory —an electrical kite. It was to take the place of the iron rod, since it could reach a greater elevation than the rod and could be flown anywhere. During a thunderstorm in 1752 Franklin flew the most famous kite in history. Sparks jumped from a key tied to the bottom of the kite string to the knuckles of his hand (Fig. 1.2). He had verified his theory, and had probably done so before he knew that D'Alibard had already obtained the same proof.

There is some controversy as to whether Franklin flew his kite in June 1752 or later that summer and whether at the time of his experiment he knew of the earlier French results (Refs. 1.3, 1.4). Curiously, it wasn't until 1788 that Franklin himself first wrote that he had performed the kite experiment; and then only a brief sentence was devoted to the subject (Ref. 1.5). Nevertheless, in October 1753 Franklin described the kite experiment in detail and stated that it had succeeded in Philadelphia — but not that he himself had performed it (Ref. 1.6). The classic account of Franklin's kite flight was written by Joseph Priestly in his History and Present State of Electricity published 15 years after the flight (Ref. 1.7). Evidence is available to show that Franklin had read Priestly's manuscript before publication and had approved of it (Ref. 1.3).

Kite flying in thunderstorm weather can be dangerous. A number of people have been killed imitating Benjamin Franklin. In the nineteenth and early twentieth century meteorological observations were made by sending instruments aloft on large box kites. In 1898, 17 U.S. Weather Bureau stations were equipped for daily kite ascensions. The kites used weighed 8 lb, carried 2 lb of instruments, and dragged as much as 20 or 30 lb of piano wire beneath them. When a kite was struck by lightning the piano wire vaporized in a bright flash. After the flash, the remains of the piano wire were briefly evident as rusty smoke.

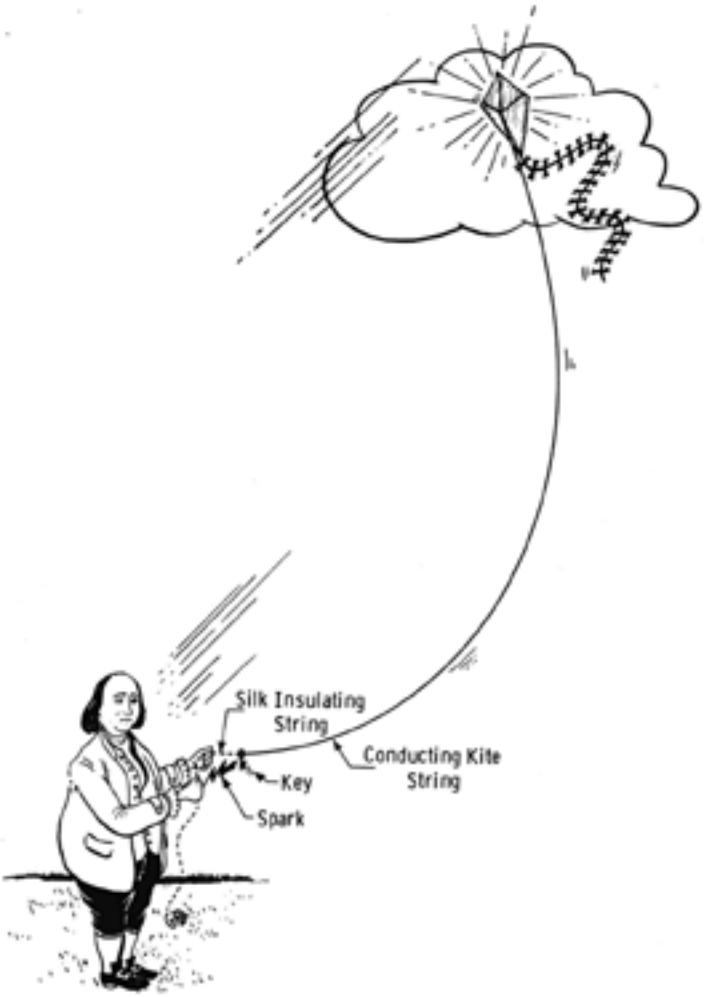

Figure 1.2: Franklin's electrical kite experiment: Sparks jump from the electrified key at the electrified kite string to Franklin's hand.

Details of two cases of lightning strikes to meteorological kites are described in Ref. 1.8. In one case a man assisting in the flight was killed. Both times, roughly a mile of wire had run out when the strike occurred.

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THE EVENT

PETRIFIED LIGHTNING FROM CENTRAL FLORIDA

A PROJECT BY ALLAN MCCOLLUM

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