Relativity

Relativity begins with a modest question: how does your physics relate to my physics if we are moving relative to each other? Galileo gave one answer: we find exactly the same laws of mechanics if our relative speed is constant.

Newton said the same thing but more elaborately by referring all motion to an absolute frame of reference in space and time. Nineteenth-century theorists found Newton's absolute frame a convenient place to locate the hypothetical medium they called the ether, which propagated light and other electromagnetic waves.

Ether physics was a prominent endeavour among Victorian scientists, but it had fatal flaws. For one thing, ether physicists could never agree on a standard model for the mechanical structure of the ether. Also questionable was the concept of motion through an ether anchored in Newton's absolute frame of reference.

A young patent examiner in Bern, Switzerland, named Albert Einstein published a paper in 1905 that resolved the ether problem by simply ignoring it. Einstein postulated two empirical principles that could not be denied: the constancy of the speed of light, and a generalisation of Galileo's relativity principle to include electromagnetic and optical phenomena. Beginning with these two principles, and without recourse to the ether concept, he proved that, for observers moving relative to each other at constant speeds, length and time measurements are different, perhaps drastically different if the speed is close to the speed of light. For example, if a stationary observer watches a clock moving at high speed he or she sees it ticking more slowly than an observer travelling with the clock.

In addition to this "time dilation," Einstein's 1905 paper insisted that the length dimension of the clock, or of anything else, is contracted in the direction of motion for the stationary observer.

Einstein designed his 1905 "special" theory of relativity with two limitations: it focused on "inertial" systems, and its scope did not include Newton's gravitation theory.

(Taken from W.H. Cropper, *Great Physicists*, OUP, New York, 2001, pp. 201-202)

EXCERCISES

1 **True or false?**

a. Newton resolved the ether problem by simply ignoring it. T F

b. When he published his paper in 1905, Einstein was teaching at Bern University. T F

c. Einstein's theory did not include Newton's gravitation theory. T F

d. Galileo did not give answers to the relativity problem. T F

2 **Complete.**

Since the time of Galileo, the concept of ..... has been in physicists' ..... The first to ..... an answer to this question was ..... He postulated that we find ..... the same laws of ..... if our relative speed is ..... Newton followed Galileo by ..... an absolute frame of ..... in space and time. The situation got more ..... with the theorisation of ..... Einstein cleared ..... the ether problem by simply ..... it, moving on to build his ..... theory.

relativity • adding • minds • constant • complicated • relativity • ether • give • reference • mechanics • ignoring • exactly • Galileo • up

3 **Match questions and answers.**

QUESTIONS		ANSWERS	
A	What were the main problems with the ether theory?	1	If a stationary observer watches a clock moving at high speed he or she sees it ticking more slowly than an observer travelling with the clock.
B	What were the foundations of Einstein's 1905 theory?	2	Physicists could never agree on a standard model for the mechanical structure of ether. Moreover, Newton's absolute frame of reference was at variance with the concept of ether.
C	Give an example of Einstein's "time dilation".	3	Two undeniable empirical principles: the constancy of the speed of light, and a generalisation of Galileo's relativity principle.

A	B	C .....