INTERPRETING GRAPHS

In science, it is critical that students be able to interpret graphs and represent scientific phenomena in graphic form. Although graphing skills are taught extensively in mathematics classes, students are often unable to apply these skills to scientific concepts. The inability of students to transfer such basic concepts should be a concern to both science and mathematics educators. The following are some suggestions for helping students develop important graphing and interpretation skills.

Terminology: Mathematics and science teachers often use different terms to describe the same concepts, and this often confuses students. Make sure that your students understand that different disciplines used different names to describe the same things.

> independent variable: Mathematicians traditionally refer to *horizontal axis* of a graph as the *x axis* or the *abscissa*, while scientists refer to it as the *independent variable*. An independent variable is one that is unaffected by changes in the dependent variable. For example when examining the influence of temperature on photosynthesis, temperature is the independent variable because it does not dependent upon photosynthetic rate. A change in the photosynthetic rate does not effect the temperature of the air! Experimenters often manipulate independent variables and look for changes in dependent variables in order to understand basic relationships.
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> dependent variable: Mathematicians refer to the *vertical axis* of the graph as the *y axis* or *ordinate*, while scientists refer to it as the *dependent variable*. The dependent variable is dependent upon changes in the independent variable. For example, photosynthesis is dependent upon temperature. A change in air temperature will result in a change in photosynthetic production
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> controls: What mathematicians refer to as constants, scientists refer to as *controls*. A control is a variable with only one value. For example, if scientists are trying to understand the relationship between temperature and photosynthetic production, it is necessary to keep other variables, such as moisture, carbon dioxide concentration, and light constant.
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> It is important to provide activities that help students understand these key terms. One such activity ("Understanding Independent, Dependent, and Control Variables") may be found on the following page.

Conceptual Understanding: Students may be able to plot algebraic and trigonometric functions on graph paper, yet have no conceptual understanding as to what such graphs mean. In science, graphs are used to describe real-life relationships between independent and dependent variables.

Interpreting Graphs: To give students a conceptual understanding of graphs, we suggest that they "walk through" some graphs. On the following pages we have provided various graphs that relate time, distance, velocity and acceleration. We suggest that students interpret the graphs by actually walking through them. Students should specify the zero point and the positive and negative directions, and then illustrate the graph by walking at various speeds and directions as described by the graph. Meanwhile, the other students in the class should examine this movement to determine if it is consistent with the graph.

Drawing Graphs: In addition to interpreting graphs, students should be able to create their own graphs. Students should graph the movement (acceleration, velocity, or distance) of the teacher as he or she performs a given movement in front of the room.

INDEPENDENT, DEPENDENT, AND CONTROL VARIABLES

(a) Given the dependent and independent variables, determine the control variables and describe an experiment which might use such variables.

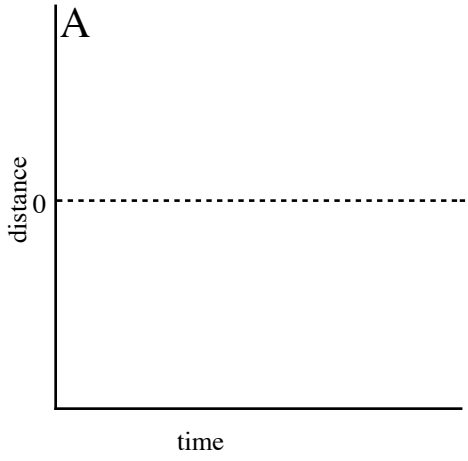
Independent variable(s)	Dependent variable(s)	Control variables	Describe experiment
pH	reaction rate		
pH of rainwater	crop production		
time	tree rings		
temperature, moisture	respiration		
phosphate concentration	time to germination		
temperature, light	photosynthesis		

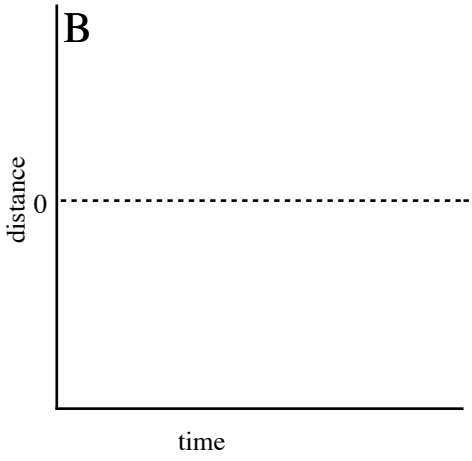
(b) Given an experiment, identify the independent and dependent variable(s), and the controls.

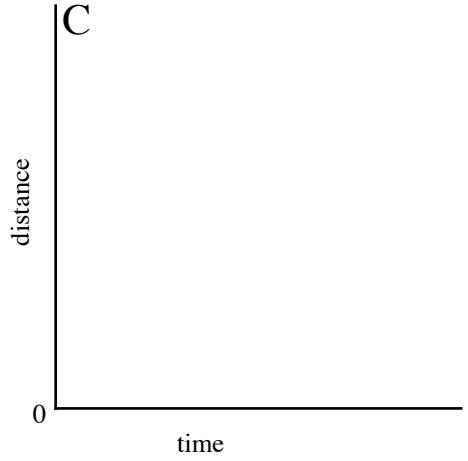
Independent variable(s)	Dependent variable(s)	Control variables	Describe experiment
			speed of sound as a function of temperature
			electric current in a photocell as a function of light intensity
			CO concentration as a function of concentration of autos.

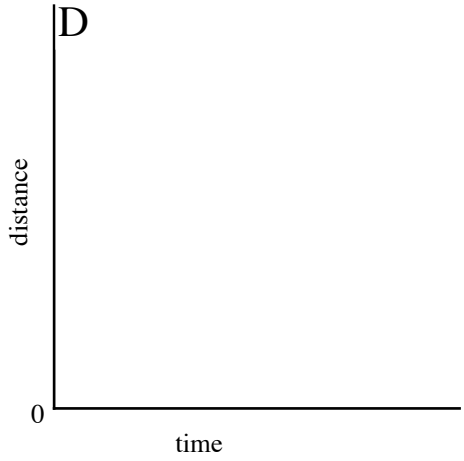
			primary productivity as a function of average temperature and rainfall.

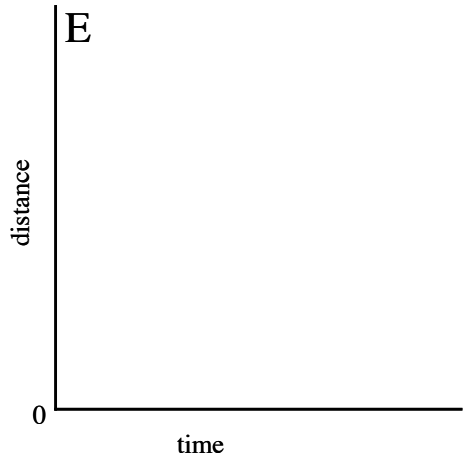
WALKING THROUGH GRAPHS

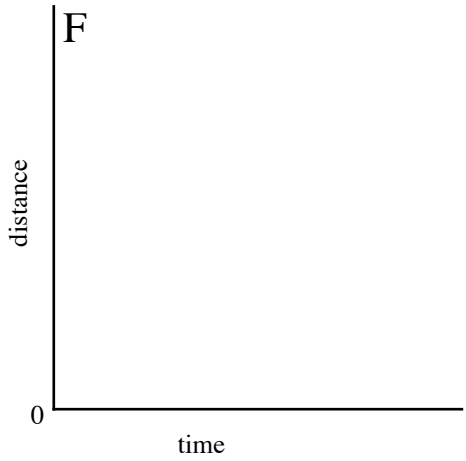












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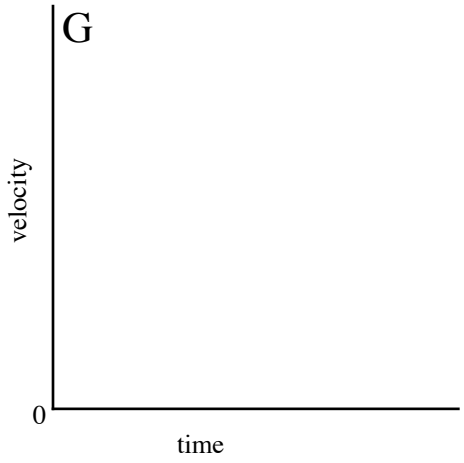
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time

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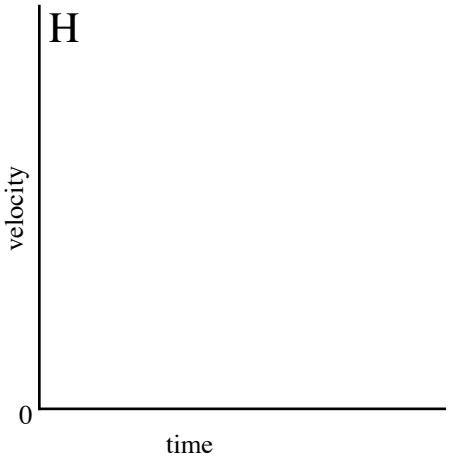
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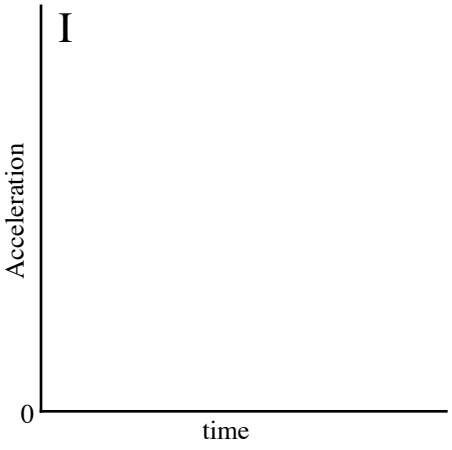
I


Acceleration
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time

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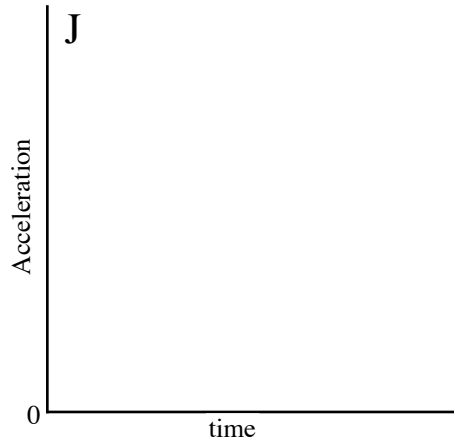
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time

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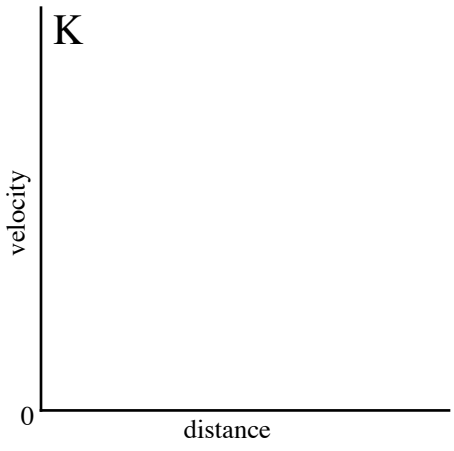
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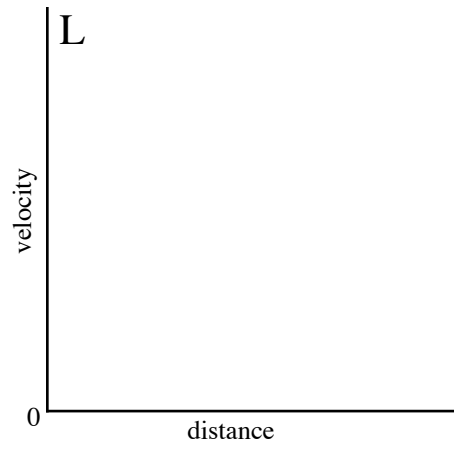
distance

L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distance