Review 3 — Words, Symbols, and Pictures

Learning physics requires something other than committing to memory a large number of names, definitions, and laws. It requires using information in an active way and in a variety of contexts. The object is to develop, largely through problem solving, an effective understanding of relatively few concepts. Invariably the questions and problems used in this learning process are presented in words, accompanied occasionally by a clarifying picture. In lower grades, you may have come to know these as "story problems".

WORDS TO SYMBOLS — ALGEBRAIC STATEMENTS

Algebraic statements. Not all physics "story- or word- problems" need be put into mathematical form, but often this is the case. Two steps needed to translate word statements into mathematical (algebraic) statements are these:

(1) The important quantities in the problem are identified and assigned symbols, such as letters of the alphabet; and

(2) the situation which is described in words is then interpreted in terms of mathematical relationships among these symbols.

Consider the following non-physics statement as an example of this two step process:

In seven years Jack will be twice as old as Bob was 5 years ago.

DISCUSSION: (1) The statement has to do with ages, so appropriate symbols are assigned to represent these: J for Jack's present age, and B for Bob's. Sometimes these letters are called "algebraic variables." As they represent measurable physical quantities, they are associated with both a number and a unit (in this case years).

(2) The relationship among the variables demands a clear understanding of the meaning of the words: "will be" and "was" imply that we must set something having to do with a future age equal to something involving some past age, requiring addition and subtraction of numbers from the present ages, respectively; "twice as old" signifies multiplication by two. Thus as an algebraic statement we have:

$$J + 7 \text{ yrs} = 2(B - 5 \text{ yrs}).$$

Since it is meaningless to add or subtract unlike things, when choosing units it is important to keep in mind the following:

Every term in an algebraic expression must have the same units.

Thus, in the last example, if J and B were chosen to represent ages in months rather than in years, the correct expression would be

$$J + 84 \text{ mo} = 2(B - 60 \text{ mo}).$$

Algebraic quantities. In choosing symbols to represent physical quantities it is convenient to choose letters which are abbreviations of the names they represent, although particular symbols are traditionally associated with certain types of quantities. For instance the symbol x often represents the distance along a horizontal line from some origin. Subscripts are frequently used; for example x_1 can be used to denote the position of an object at one time and x_2 to denote its position at a later time.

Physics also makes use of the Greek alphabet. It is worthwhile being familiar with some of the more commonly used Greek letters, as given in the following table:

Some Greek letters often used in beginning physics.*

α	alpha	θ	theta	σ	sigma
β	beta	λ	lambda	Σ	UC sigma
γ	gamma	μ	mu	φ	phi
δ	delta	υ	nu	ω	omega
Δ	UC delta	ρ	rho	Ω	UC omega

*Lower case unless indicated UC.

WORDS TO SYMBOLS — MAKING AND USING DIAGRAMS

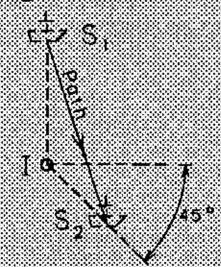
Representing relationships — especially spatial relationships. To express the connections among algebraic quantities, a limited number of symbols can be used to represent an almost unlimited number of word statements. For instance, the expression "added to" usually appears in an algebraic statement in terms of the symbol "+", but this same symbol can be used to denote such words as "increased," "enlarged," "grow," "taller," "more," etc.

Practicing with word problems is invaluable for developing skill at symbolizing statements. However in many physics situations, especially where a problem has to do with relative positions of objects, drawing a simple diagram makes it easier to grasp the situation, so that the words can be readily interpreted.

A simple drawing which depicts the spatial arrangements described in a problem greatly aids understanding.

This is illustrated by the next example:

A radar operator on a small island (labelled I below) determines that a ship is 15 km due north of him. Some time later the ship is 10 km southeast of the island. If the ship moves in a straight line, draw a diagram showing the ship's path.



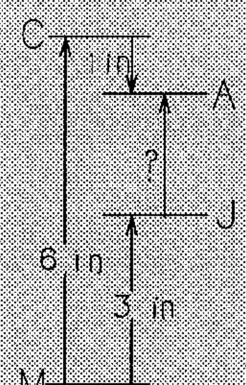
DISCUSSION: Many problems in physics involve the relative orientation of objects in a plane, such as the situation described here. Appropriate drawings are much like maps. It is often useful to label the angles which show the orientation of important lines in the diagram, as in this sketch showing the earlier and later positions of the ship S_1 and S_2.

A drawing need not be fancy; a reasonably careful freehand sketch will usually do.

Getting an answer from a diagram. Not only can a simple sketch help you to understand a problem, but it may sometimes provide a quick insight into the answer, as in the following example:

Carol is 6 inches taller and John is 3 inches taller than Marty. If Alfred is one inch shorter than Carol, how much taller (or shorter) is Alfred than John?

DISCUSSION: A sketch resembling height marks on a wall proves useful in this problem, as it reveals the answer essentially by inspection.



From the drawing we see directly that Alfred is 2 inches taller than John.

Although algebra can be used to solve a problem of this type, it isn't always necessary. In this example making the diagram leads to the answer without any complicated mathematics.

A diagram need not always represent a spatial relationship. It can be more abstract. For instance, if the above problem were changed to an "age" problem, by substituting "years" for "inches" and "older/younger" for "taller/shorter," the solution could be found using exactly the same diagram.