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Basic Math Package Available

IBM's recently announced MATH/BASIC program product is a library of routines for solving the most common mathematical problems in science, engineering, and related fields. Written in the BASIC language, the routines are designed for the System/3 Model 6 as well as for terminal

use with a System/360/370 with ITF. MATH/BASIC consists of 40 routines that cover linear equations, matrix eigenvalue problems, polynomial equations, zeros and extrema of functions, quadrature, differentiation, interpolation, approximation, smoothing, differential equations, the fast Fourier transform, and special functions.

Two Computer Physics Games

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The two computer games described below have been used for the past several years by students in our course for nonscience majors. They have stimulated interest in kinematics, and have introduced students to the operation of the computer.

The Stoplight Dilemma. This game is based on Seifert's analysis¹ of the options open to a motorist approaching a traffic light. The light turns from green to yellow while the car, which is traveling at a known velocity, is at a given distance from the beginning of the intersection. The width of the intersection and the length of time during which the light is yellow are also known. Should the motorist step on his brake pedal or on his accelerator pedal? If he misjudges the relationships between his negative acceleration while braking, his positive acceleration as he presses on the accelerator pedal, his velocity and the distance to the intersection, he stands a chance of causing an accident or being given a ticket. Under certain circumstances, there is no way in which he can avoid being in the intersection at the wrong time. Fortunately, most drivers have had enough experience so that the required calculations are bypassed, and the proper choice is made instinctively.

In using this program, the student is requested to enter the distance to the intersection at the

time when the light turns yellow, the initial velocity, and the positive and negative accelerations possible with a certain car. The stopping distances in feet for an initial velocity of 60 mph and the starting times from 0 to 60 mph have previously been supplied to permit the accelerations to be calculated. These data are obtained from *Consumer Reports* for a range of light and heavy cars, and empty and loaded pickup trucks. It is interesting to note that the negative acceleration is usually several times larger in magnitude than the positive acceleration. In most situations it is better not to try to beat the traffic light.

The output is a displacement-time graph which is printed out on the line printer. A curve is plotted with minus signs to indicate the motion of the car with the brakes on, and a second curve is plotted with plus signs to give the motion of the car with the accelerator pedal floored. There is a forbidden region on the graph in which the car may not exist safely; this is the width of the intersection after the time when the light turns red.

The Commuter-Train Problem. This is the familiar problem² of a commuter emerging from the waiting room of a train station, and seeing the train pulling out a distance down the track. The commuter runs toward the train with a constant velocity, and the train has a constant acceleration. Will the commuter catch the train? From a pedagogical viewpoint, this is an excellent problem since an analytic solution of a quadratic equation is required, and the student must decide how to interpret the two solutions.

The student must enter the initial velocity of the commuter, and the initial position and velocity and constant acceleration of the train. If the

commuter misses the train, the student is told to try again with new initial conditions. If the commuter does catch the train, a message giving the distance which the commuter ran and the elapsed time is typed out. A displacement-time graph is plotted on the line printer to show the two points at which the commuter may board the train.

These programs are written in FORTRAN IV and are used on an IBM 1130 computer. Program listings and typical data are available from the author.

¹ Howard S. Seifert, *Amer. J. Phys.* **30**, 216 (1962).

² For example, see Franklin Miller, Jr., *College Physics* (Harcourt Brace Jovanovich, New York, 1972), 3rd ed., p. 52, Prob. 3-C1.

Simple Visual Exercises with Electric Forces and Fields

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Two drill exercises have been programmed for computer-based instruction which test the student's basic understanding of the electric fields and forces for point charges. These have been used on the University of Illinois PLATO system with graphic display, but are presented here in a form suitable for use with teletype terminals.

The first exercise deals with the directions of F and E . The printout seen by the student is self-explanatory.

RESPOND TO THE NEXT FEW QUESTIONS BY TYPING
U, D, R, L (FOR UP, DOWN, RIGHT, OR LEFT) or
1, 2, 3, 4 (DIAGONALS) TO INDICATE THE APPROXIMATE
DIRECTION OF THE ELECTRIC FIELD OR FORCE
AT A POINT

4 U 1

.

L . . . R

.

3 D 2

1a) $+Q$ $+q$ FORCE ON $+q$?
[STUDENT TYPES R] OK

1b) $+Q$ x E-FIELD at x?
[STUDENT TYPES L]

UNLIKE CHARGES ATTRACT, LIKE CHARGES REPEL.

TRY AGAIN. (STUDENT TYPES R) OK
CHARGE $+q$ WILL BE MOVED AROUND TO NEW
POSITIONS.

WATCH FOR IT AND GIVE THE DIRECTIONS OF F OR
 E AT EACH NEW POINT.

2a) $+q$
 $+Q$ FORCE ON $+q$? (STUDENT TYPES U)
OK
...

After a number of exercises have been attempted with both positive and negative charges and a certain percentage answered correctly, the student is led to a generalization about the direction of the electric field about a point charge, and a short self-test is administered.

The second exercise covers the magnitudes of F and E with various charge configurations. For example:

3) COMPARE THE MAGNITUDES OF THE FORCES
ON $+q$ IN CASE (a) AND (b).
ANSWER G (GREATER THAN), L (LESS THAN)
OR E (EQUAL).
a) Q q
b) Q q
 F_a () F_b [STUDENT TYPES G] OK

Appropriate corrective replies are given for wrong answers. For example, if the student types L in the above exercise, the computer replies:

CHARGE q IS CLOSER TO Q IN CASE (a) THAN IN (b)
AND SHOULD FEEL A STRONGER FORCE SINCE $F=kQq/r^2$.