

# Simple Scripts to Produce Interactive Web-Based Tests with Immediate Feedback: Software and Illustration

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## ABSTRACT

Web publication is increasingly utilized in education. This paper is written to contribute a basic yet versatile software, with illustration, for creating interactive web-based modules for tests with immediate feedback. Each module assists students in learning new material by offering "tips," without providing answers right away, when wrong answers are chosen. The software is segmented into five program files, where the first two are subject specific while the other three are general. Being independent of web sites, the three general program files need no changes by users and are included, with ample comments, in the appendices. Beginning instructors can readily create web-based modules by directly modifying the two subject specific program files.

## I. INTRODUCTION

The World Wide Web (WWW) is a very powerful tool for communication. Generally, the WWW is an environment where the information created is accessible on demand, anytime, and anywhere. It has been used by organizations and individuals for various purposes. In education, it is capable of allowing on-demand access to any information and material for a given course or for tutoring, which an instructor provides at a web site. In particular, the WWW can be used to great advantage in teaching high enrollment courses as well as distance education. Increasing efforts to create web-based educational material on the WWW clearly point to the trend of using web publication as an alternative mode in modern education.<sup>1-6</sup>

It is the purpose of this paper to present a basic yet versatile software that uses Practical Extraction and Report Language (PERL) and Common Gateway Interface (CGI) scripting<sup>7-8</sup> to manipulate data files to readily create modules for interactive on-line testing with immediate feedback. It allows as well as promotes learning because appropriate "tips" are offered, without providing answers right away, when wrong answers are chosen by students. Note that PERL is a programming language like C or FORTRAN.

A CGI script is simply a program that is run on a web server based on input from a browser. It enables users to interact with the web

pages. For example, when a web user fills in a form or a search dialog on the web, the user has used a CGI script. Generally, CGI scripts are basic sets of variables and mechanisms for passing information from the browser to the server. A CGI script can be used as the *action* to a form or as a direct link. The script may take input from the browser, manipulate it, and display the results on a new browser page. Depending on what the web server supports, CGI scripts can be batch files, compiled programs, or any other executable entity. The scripts may be written in any language as long as the web server supports that language. For example, a CGI script can be written in C as long as the server supporting the web page supports the C language. In our case, the CGI scripts are written in PERL.

The software contributed in this paper is written for any educational professional with a moderate knowledge of how a web site works. The software consists of the following five files:

- (a) One gateway file: test.html,
- (b) One data file: test#.dat,
- (c) Three general program files: testrad.cgi, ans1.cgi, and ans2.cgi.

With this setup, an instructor can directly modify the gateway file and the data file for a given subject and simply employ the general program files with no change. We acknowledge Steven E. Brenner<sup>8</sup> for using his library routine, *cgi-lib.pl*, which he has granted conditional permission to users, and which is downloadable from the site: <http://cgi-lib.stanford.edu/cgi-lib/>. Note that the *cgi-lib.pl* has long been used as a library for creating CGI scripts in the PERL language.

The aforementioned five contributed files and the library routine *cgi-lib.pl* may be saved in an appropriate directory in the instructor's computer account, where the server supports PERL and CGI scripting. For illustrative purposes, we have saved them in the directory "webtest" at the web site: <http://engr.uark.edu/~icj/webtest/>. Naturally, other relevant files may also be saved in this directory. To be sure, an instructor should consult the system administrator of the local server about the protocol for the proper setup for CGI scripts written in PERL. Note that many C commands will work with PERL. A good on-line reference manual for PERL programming can be found at the web site: <http://www-cgi.cs.cmu.edu/cgi-bin/perl-man>.

## II. INTERACTIVE WEB-BASED TESTS

Pictures are often invaluable in presenting new ideas to readers. The setup of a gateway page for students and a typical adventure in an interactive web-based test are illustrated in the screen shots in figures 1 through 8. Generally, a student uses a browser (e.g., Netscape Navigator 4.5 or Internet Explorer 5) on a computer to sign on to a gateway page for taking web-based tests, which have

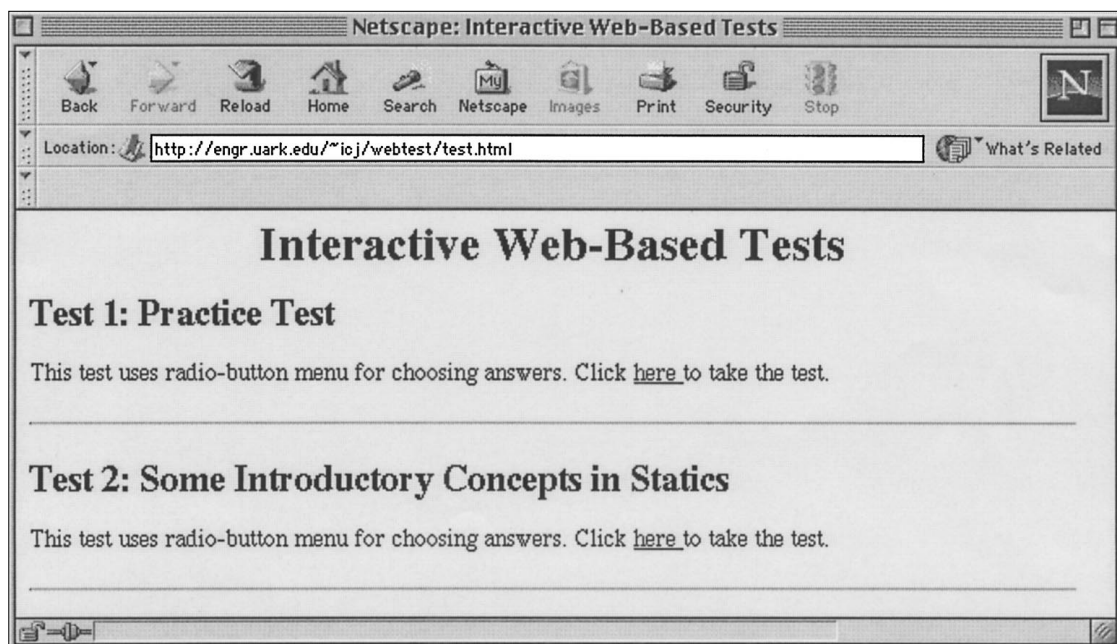


Figure 1. The gateway page for taking web-based tests.

been set up by an instructor. In the presented illustration, the gateway page is located at <http://engr.uark.edu/~icj/webtest/test.html>.

The student may first take a simple practice test to gain familiarity with a web-based test. The tests available to the students for testing and learning are listed on the gateway page as illustrated in figure 1. Suppose that the student proceeds to click on the word here under Test 2 on this gateway page, the test created by the instructor will appear as illustrated in figure 2. The student reads the instruction at the top of the test page, clicks black dots onto appropriate radio buttons to mark chosen answers as shown in figure 3, then clicks the SUBMIT button to have the test graded as shown in figure 4.\* The student should study the comments, besides the test score, on this feedback page. In particular, note that a “tip” is offered when a wrong choice was made by the student, without giving out the correct choice right away, to promote learning.

If incorrect choices were noted on the feedback page (e.g., figure 4), the student is to study the corresponding “tips” carefully and, then, click the word here below the score on this page to take the test over. When the student follows this option, the same test will appear on the screen as illustrated in figure 5.\*\* Note in this figure

that the order of prospective answers in each question has been randomized by the program whenever a student takes the test over. The rearranged order of the prospective answers in each question would require the student more thinking and understanding than just memorization in choosing the correct answers. Since the questions in each retake involve the same concepts to be mastered, there is little uncertainty and no information overload. Thus, much *more* learning and confidence building for the students would take place.

Eventually, the student will master the concepts and be able to choose correct answers as illustrated in figure 6\* and confirmed in figure 7.\*\* The time of submittal of the test for grading, shown on feedback pages, may serve as a record of progress that can be printed on paper as hard copies. The correct choices and explanations for the test can be viewed by clicking the word here on the last line of any feedback page. The key to Test 2 is shown in figure 8.

### III. GATEWAY FILE: test.html

The file test.html is a program to create the gateway page shown in figure 1, which the students first see when they sign on to the

\*In figure 4, we note the following features:

- The time of submittal of the test for grading is recorded on the feedback that can be printed.
- A tip is offered when a wrong choice was made by the student, without giving out the correct choice right away, to promote learning.
- A positive comment for immediate reinforcement is given whenever a correct choice was made.

Furthermore, notice in the last two lines in figure 4 that the student is offered two options: (a) click to take the test over, (b) click to see the correct choices and explanations (i.e., the *key* to the test).

\*\*By comparing the question statements and the order of prospective answers in figure 5 with those in figure 2, we note the following features:

- The question statements remain the same.
  - The order of prospective answers in each question has been randomized by the program whenever a student takes the test over.
  - A student may take the test over multiple times.
- These features enhance the learning of students.

\*In figure 6, we note the following features:

- The rearranged order of the prospective answers in each question would require the student more thinking and understanding than just memorization in choosing the correct answer.
  - The student takes essentially the same test over.
- Since the questions in each retake involve the same concepts to be mastered, there is little uncertainty and no information overload.

\*\*In figure 7, we note the following features:

- The time of subsequent submittal of the test for grading, shown on the feedback, now serves as a record of progress that can be printed.
- Positive comments continue to be given whenever correct choices were made.
- No tips or hints are needed because the student has answered all questions correctly this time.

Although the last two lines in figure 7 still list two options, only the second option—click to see the explanations—may be of interest to this student.

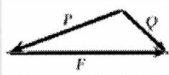
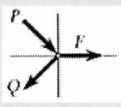
Netscape: Interactive Web-Based Tests

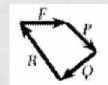
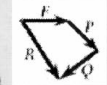
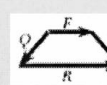
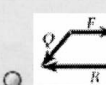
Back Forward Reload Home Search Netscape Images Print Security Stop

Location: <http://engr.uark.edu/~icj/webtest/testrad.cgi/~icj/webtest/test2.dat/number=1> What's Related

## Test 2: Some Introductory Concepts in Statics

**Instruction:** Click on a radio button to choose the best item, as listed, for each of the following. Then, click the SUBMIT button.

- (5 Points) Rounding the number 0.03065 to three significant digits, we get
  - ☐ 0.03
  - ☐ 0.0307
  - ☐  $3.065 \times 10^{-2}$
  - ☐ 0.031
  - ☐ 0.0306
- (5 points) The base unit for mass in SI is
  - ☐ newton
  - ☐ pound-mass
  - ☐ kilogram
  - ☐ slug
  - ☐ gram
- (10 points) One newton is defined as
  - ☐ the net force required to accelerate a mass of 1 kg at  $1 \text{ m/s}^2$
  - ☐ the net force required to accelerate a mass of 1 slug at  $1 \text{ ft/s}^2$
  - ☐ the weight of a 1-kg mass
  - ☐ the weight of a 1-slug mass
  - ☐ the net force required to accelerate a mass of 1 kg at  $9.80665 \text{ m/s}^2$
- (10 points) Which of the following equations correctly relates the vectors  $F$ ,  $P$ , and  $Q$ , as shown?
 
  - ☐  $F - Q = P$
  - ☐  $F - P = Q$
  - ☐  $F + Q = P$
  - ☐  $P + Q = F$
  - ☐  $P + F = Q$
- (10 points) Three vectors  $F$ ,  $P$ , and  $Q$  are shown. Which figure contains the vector  $R$  that correctly represents the resultant of the three vectors shown?
 

SUBMIT RESET

Figure 2. The test that appears when the word here under Test 2 on the gateway page in figure 1 is clicked.

web site for Interactive Web-Based Tests. It is written in HTML (HyperText Markup Language).<sup>9</sup> It lists the tests that have been developed and are available to the students. When a test is selected from this gateway page, the browser causes the general program file testrad.cgi to be run on the server to process the data file test#.dat

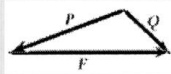
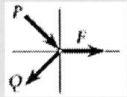
(e.g., test1.dat or test2.dat) and to display the test on the computer screen. Since the relevant files are saved in the directory "webtest" at the site: <http://engr.uark.edu/~icj/webtest/>, the source program of this HTML file, written to display just two tests as shown in figure 1, is accordingly illustrated in figure 9.


Netscape: Interactive Web-Based Tests


Location: <http://engr.uark.edu/~icj/webtest/testrad.cgi/~icj/webtest/test2.dat/number=1>


### Test 2: Some Introductory Concepts in Statics


**Instruction:** Click on a radio button to choose the best item, as listed, for each of the following. Then, click the SUBMIT button.

- (5 Points) Rounding the number 0.03065 to three significant digits, we get
  - ☐ 0.03
  - ☒ 0.0307
  - ☐  $3.065 \times 10^{-2}$
  - ☐ 0.031
  - ☐ 0.0306
- (5 points) The base unit for mass in SI is
  - ☐ newton
  - ☐ pound-mass
  - ☒ kilogram
  - ☐ slug
  - ☐ gram
- (10 points) One newton is defined as
  - ☒ the net force required to accelerate a mass of 1 kg at  $1 \text{ m/s}^2$
  - ☐ the net force required to accelerate a mass of 1 slug at  $1 \text{ ft/s}^2$
  - ☐ the weight of a 1-kg mass
  - ☐ the weight of a 1-slug mass
  - ☐ the net force required to accelerate a mass of 1 kg at  $9.80665 \text{ m/s}^2$
- (10 points) Which of the following equations correctly relates the vectors F, P, and Q, as shown?
 
  - ☐  $F - Q = P$
  - ☐  $F - P = Q$
  - ☐  $F + Q = P$
  - ☒  $P + Q = F$
  - ☐  $P + F = Q$
- (10 points) Three vectors F, P, and Q are shown. Which figure contains the vector R that correctly represents the resultant of the three vectors shown?
 


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SUBMIT RESET

Figure 3. Black dots clicked onto radio buttons to mark chosen answers on the test by a student who has some difficulty.

This HTML file does reflect that both of the files `testrad.cgi` and `test#.dat` are presently saved in the sub-directory `webtest` under the user directory `~icj` in the server `engr.uark.edu` on the Internet. These directories and files must have attributes that allow public access on the WWW. Here, an instructor

needs to correspondingly modify only the *names* of these directories and the server in this HTML file. Note that the second instance of "`~icj`" in each underlined text is *not* preceded by a space. Naturally, this file may be written to display more available tests.

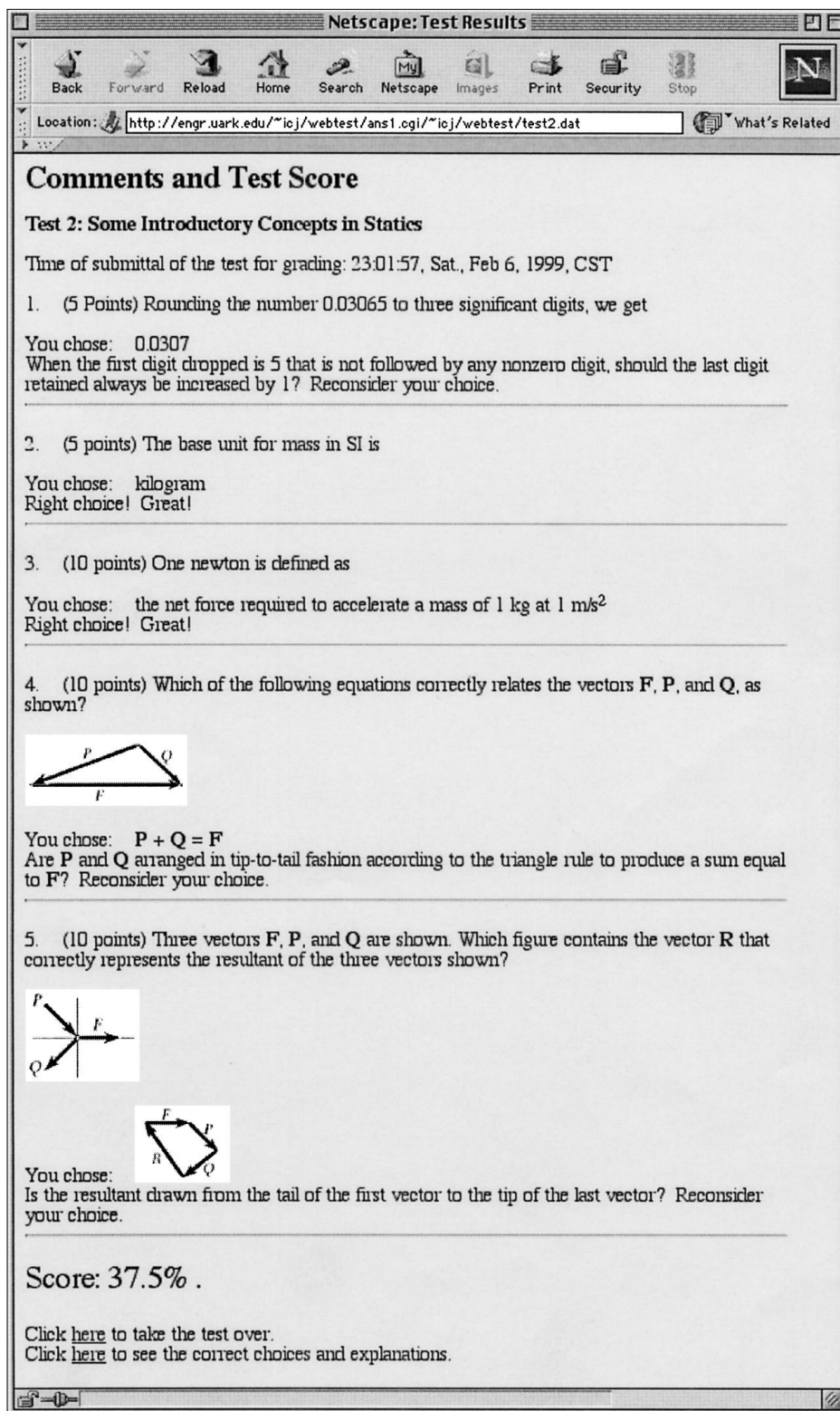


Figure 4. The immediate feedback to the student, who SUBMITTED the chosen answers shown in figure 3 for grading.

#### IV. DATA FILE: test#.dat

This file provides data for creating an interactive web-based test. For illustration, we make a test, called Test 2, which refers to *Some Introductory Concepts in Statics*. It is a multiple-choice

test consisting of five different types of questions. Each question has four or five prospective answers. A question may have a figure in the statement of the question, or in the answer, or both. Credit points are not the same for all questions. Additionally, we shall use superscripts for powers and boldface letters for vectors. Appropriate tips, comments, and explanations, are to be

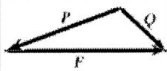
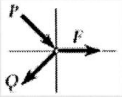
Netscape: Interactive Web-Based Tests

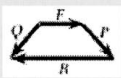
Back Forward Reload Home Search Netscape Images Print Security Stop

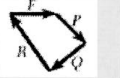
Location: <http://engr.uark.edu/~icj/webtest/testrad.cgi/~icj/webtest/test2.dat/number=33> What's Related

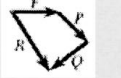
## Test 2: Some Introductory Concepts in Statics

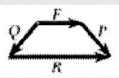
**Instruction:** Click on a radio button to choose the best item, as listed, for each of the following. Then, click the SUBMIT button.

- (5 Points) Rounding the number 0.03065 to three significant digits, we get
  - ☐ 3.065 x 10<sup>-2</sup>
  - ☐ 0.031
  - ☐ 0.0306
  - ☐ 0.03
  - ☐ 0.0307
- (5 points) The base unit for mass in SI is
  - ☐ kilogram
  - ☐ slug
  - ☐ gram
  - ☐ newton
  - ☐ pound-mass
- (10 points) One newton is defined as
  - ☐ the weight of a 1-kg mass
  - ☐ the weight of a 1-slug mass
  - ☐ the net force required to accelerate a mass of 1 kg at 9.80665 m/s<sup>2</sup>
  - ☐ the net force required to accelerate a mass of 1 kg at 1 m/s<sup>2</sup>
  - ☐ the net force required to accelerate a mass of 1 slug at 1 ft/s<sup>2</sup>
- (10 points) Which of the following equations correctly relates the vectors **F**, **P**, and **Q**, as shown?
 
  - ☐  $P + Q = F$
  - ☐  $P + F = Q$
  - ☐  $F - Q = P$
  - ☐  $F - P = Q$
  - ☐  $F + Q = P$
- (10 points) Three vectors **F**, **P**, and **Q** are shown. Which figure contains the vector **R** that correctly represents the resultant of the three vectors shown?
 


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SUBMIT RESET

Figure 5. The test that appears when the student clicks to choose taking the test over, where the answers are rearranged.

keyed to correspond to the various prospective answers. Such an interactive test, illustrated in figures 2 through 8, is created using the data file test2.dat, which is presented in figure 10, where the tags (highlighted in boldface) are explained in tables 1 and 2.

The data file test2.dat illustrates five different types of questions. This file may serve as a template, with tables 1 and 2 as guides, in creating a test. In this file, notice the following:

- A # sign, followed by a space, at the start of a line signifies a comment line, and such a line is ignored during processing.

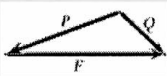
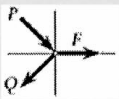


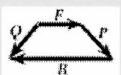
Netscape: Interactive Web-Based Tests


Location: <http://engr.uark.edu/~icj/webtest/testrad.cgi/~icj/webtest/test2.dat/number=33> What's Related


## Test 2: Some Introductory Concepts in Statics

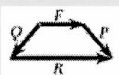
**Instruction:** Click on a radio button to choose the best item, as listed, for each of the following. Then, click the SUBMIT button.

- (5 Points) Rounding the number 0.03065 to three significant digits, we get
  - ☐  $3.065 \times 10^{-2}$
  - ☐ 0.031
  - ☒ 0.0306
  - ☐ 0.03
  - ☐ 0.0307
- (5 points) The base unit for mass in SI is
  - ☒ kilogram
  - ☐ slug
  - ☐ gram
  - ☐ newton
  - ☐ pound-mass
- (10 points) One newton is defined as
  - ☐ the weight of a 1-kg mass
  - ☐ the weight of a 1-slug mass
  - ☐ the net force required to accelerate a mass of 1 kg at  $9.80665 \text{ m/s}^2$
  - ☒ the net force required to accelerate a mass of 1 kg at  $1 \text{ m/s}^2$
  - ☐ the net force required to accelerate a mass of 1 slug at  $1 \text{ ft/s}^2$
- (10 points) Which of the following equations correctly relates the vectors **F**, **P**, and **Q**, as shown?
 
  - ☐  $P + Q = F$
  - ☒  $P + F = Q$
  - ☐  $F - Q = P$
  - ☐  $F - P = Q$
  - ☐  $F + Q = P$
- (10 points) Three vectors **F**, **P**, and **Q** are shown. Which figure contains the vector **R** that correctly represents the resultant of the three vectors shown?
 


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SUBMIT RESET

Figure 6. Black dots clicked onto radio buttons to mark chosen answers on the test by the student who takes it over.

- It may conveniently be used to number the questions in the test.
- If there are several sets of data files to create several tests, they may be named sequentially, such as, test1.dat, test2.dat, . . . , etc. The HTML tags used in these files will work on the web.

- The title listed under the tag **title**: is needed by viewers in identifying the test on the web page.
- The listing of the location of the directory under the tag **loc**: is what makes the general program files independent of the web sites of the users.

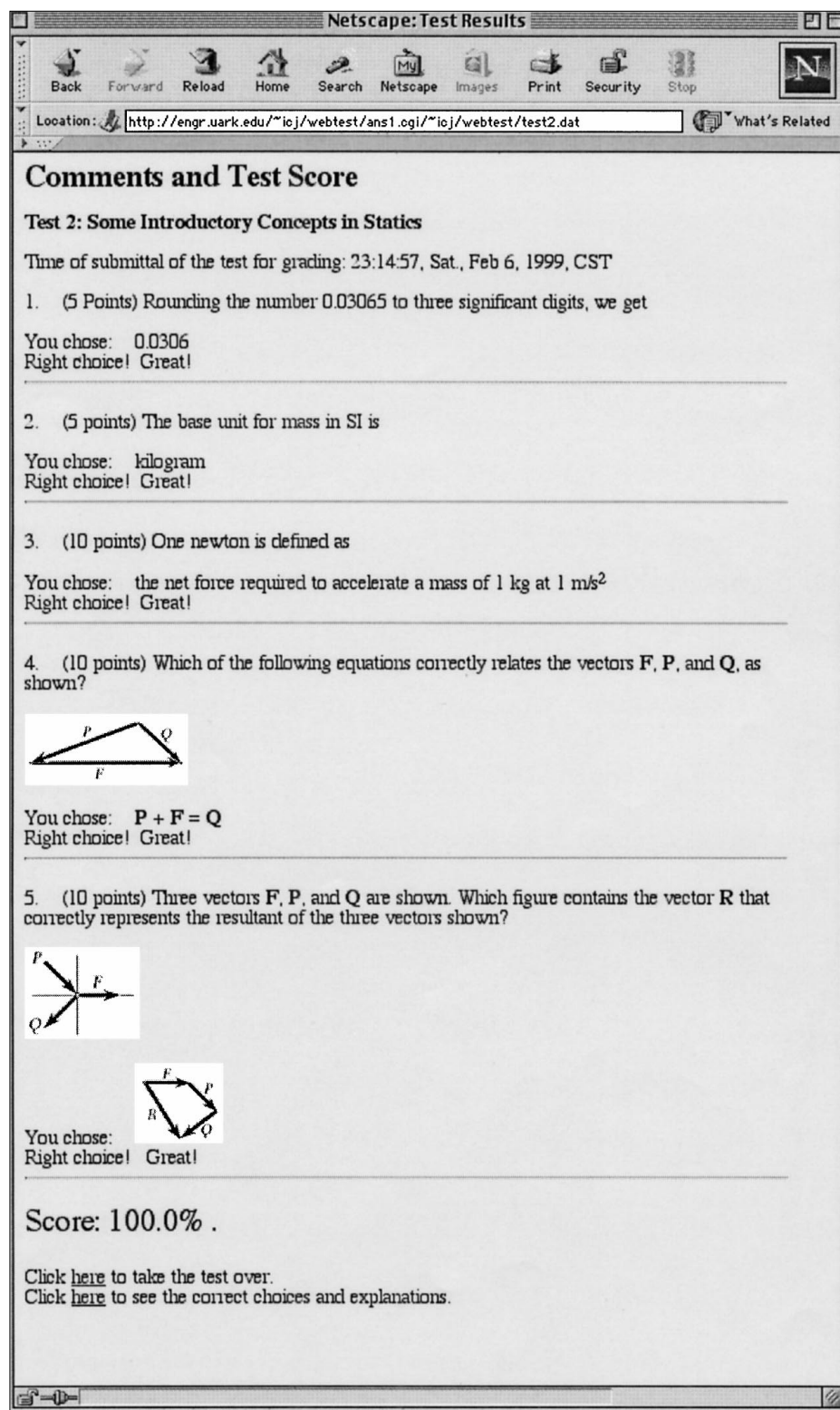


Figure 7. 100 %—the feedback to the student, who SUBMITTED the chosen answers shown in figure 6 for grading.

- Each question may contain up to eight tagged items, but the three tags **question:**, **answer:**, and **&** are the minimum required.
- Each tagged item must start with a tag and must be typed in one line that may involve wrapping; i.e., no <return> or <enter> key should be pressed in typing a tagged item.
- Semicolons are used as separators for items listed under the tags **apicture:**, **answer:**, and **tip:**. Thus, no one of these listed items can have a semicolon as a punctuation mark within itself.
- A + sign should precede the first character of the correct answer in the list under the tag **answer:**; it must be the first character to follow the semicolon if the correct answer is not placed



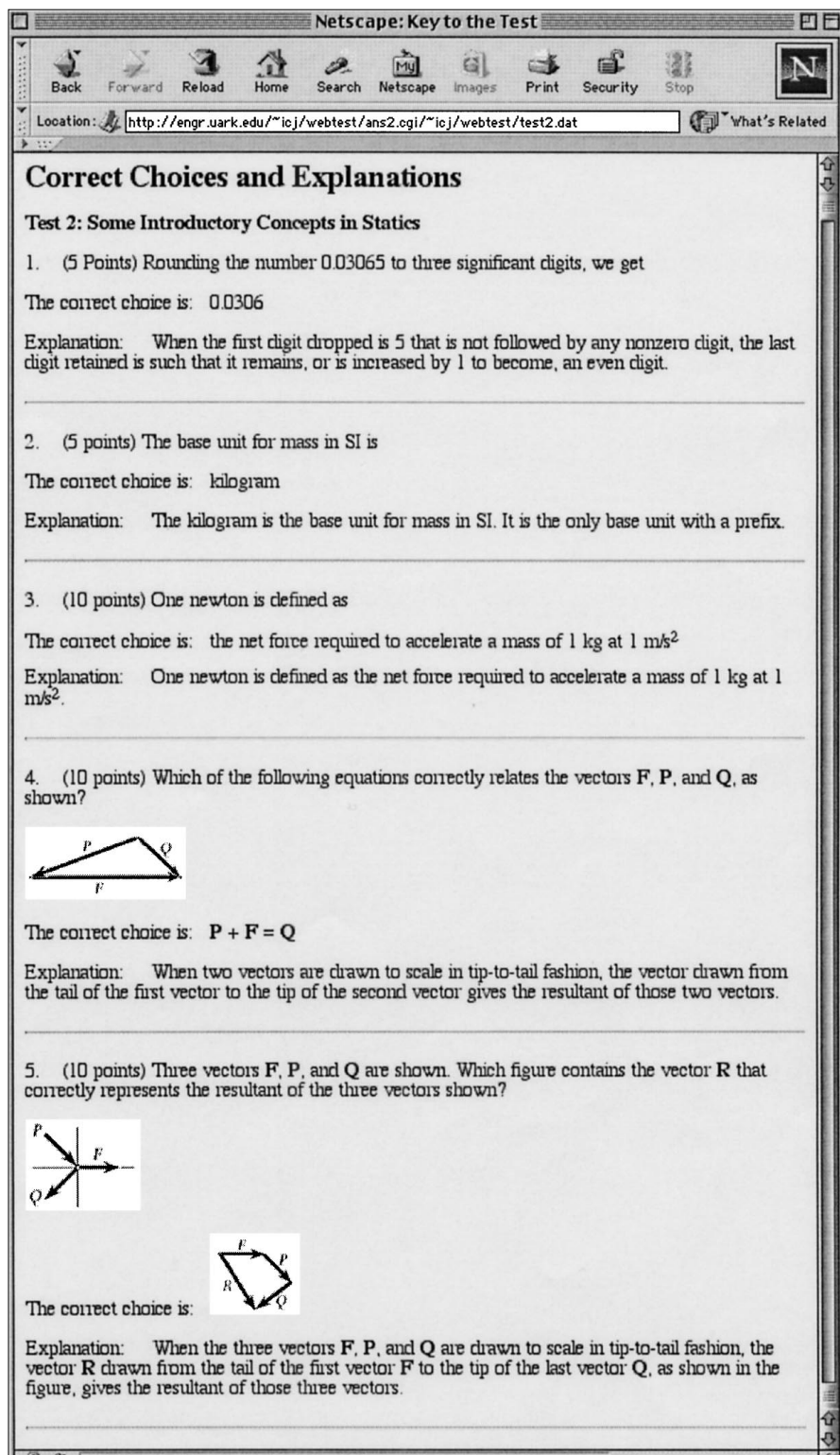


Figure 8. Key to test.

at beginning of the list. If the correct answer starts with a + sign as part of the answer, then there are two consecutive + signs.

- Question #5 contains the maximum number of tagged items. The tag **apicture:** is used in this question, and the listed pictures will be displayed as prospective answers. Thus,

the items listed under the tag **answer:** are treated as dummy ones. The dummy ones may be listed as pic1; pic2; pic3; + pic4, where the + sign in front of "pic4" is used to signify that the correct picture (or graphic item) listed under the tag **apicture:** is correspondingly the 4th listed item. In other words, <http://engr.uark.edu/~icj/webtest/t2figs/fig2.5d.gif> is the location for the correct answer picture for question #5.

## test.html

```
<HTML><HEAD><TITLE>Interactive Web-Based Tests</TITLE></HEAD>
<BODY LINK="#0000ff" VLINK="#800080" BGCOLOR="#fff8dc">
<H1 ALIGN="CENTER">Interactive Web-Based Tests</H1>

<H2>Test 1: Practice Test</H2>
<P>This test uses radio-button menu for choosing answers. Click <A
HREF="http://engr.uark.edu/~icj/webtest/testrad.cgi/~icj/webtest/test1.
dat">here </A>to take the test.</P><HR>

<H2>Test 2: Some Introductory Concepts in Statics</H2>
<P>This test uses radio-button menu for choosing answers. Click <A
HREF="http://engr.uark.edu/~icj/webtest/testrad.cgi/~icj/webtest/test2.
dat">here </A>to take the test.</P><HR>

</BODY></HTML>
```

Figure 9. test.html.

## V. PROGRAM FILES

### A. Program File: testrad.cgi

The program file testrad.cgi consists of CGI scripts written in PERL. This program, as well as other CGI programs, starts with `#!/usr/local/bin/perl` as its first line, where the `#` sign is followed by the exclamation point `!`. This first line of the program points to the location of the PERL interpreter in the server so that the remaining code in the program can be properly executed. Make sure a copy of PERL resides in the subdirectory `/usr/local/bin/` of the server. If a line starts with the `#` sign followed by one or more spaces, it is a *comment* line and will be ignored in the execution of the program.

This program file is first called by the gateway file test.html when a student clicks the word here to select a test to take on the gateway page for taking a web-based test, as shown in figure 1. The program then reads the data for the test from the file test#.dat (e.g., test2.dat). It displays the test on the screen and uses radio-buttons to list the prospective answers on the test. The SUBMIT and RESET buttons are provided at the bottom of the test page. Upon completing the choices of answers, the student is to click the SUBMIT button, which causes the program ans1.cgi to be executed. The file testrad.cgi is listed, with ample comments, in Appendix A.

### B. Program File: ans1.cgi

The program file ans1.cgi is another program consisting of CGI scripts written in PERL. This program is first called into action by the program testrad.cgi to grade the submitted test, give tips or comments, and allow students opportunities to take the test over. This program calls the program ans2.cgi, which will handle the presentation of correct choices and explanations for the test. The file ans1.cgi is listed, with ample comments, in Appendix B.

### C. Program File: ans2.cgi

The program file ans2.cgi is the last contributed program, which consists of CGI scripts written in PERL. This program is called into action by the program ans1.cgi. The main task of the program ans2.cgi is to handle the display of the correct answers and explanations for the logic behind the correct answers. In other words, this program displays the key to the test when a re-

quest to see the correct choices and explanations is made by clicking the word here on the last line of the feedback page (e.g., figure 4 or 7). The file ans2.cgi is listed, with ample comments, in Appendix C.

## VI. BENEFITS AND ISSUES

An educational software tool, which is practical, versatile, powerful, general, user-friendly, well-documented, and *freely available*, is highly desirable. We thought the software tool that we presented and illustrated in this paper has attributes that match or are close to those just described. That is why we would like to share it with other educational professionals.

### A. Benefits

The software presented in this paper can readily be modified to require passwords from users for using the web-base tests. It can be expanded to incorporate audio and video clips. At present, the software presented is, however, intended as a versatile tool to do the following:

- Teach *new* or *remedial* concepts and material in any subject via interactive web-based tests to any number of students, on demand, any time, and anywhere. This is possible once the modules for testing and learning (e.g., test2.dat) have been developed by an educational professional and the access to the World Wide Web on the Internet is available. Although the name of the game is "web-based test," there is actually a lot of *learning* experience to be gained by the students because it offers "tips" to them, without providing answers right away, when they made incorrect choices. Students could take the test again and still get something out of the experience. This feature is not readily matched by the conventional tests!
- To accommodate different *biological clocks* and different *learning styles* of the students. Some students are of the early-bird type, whose most effective hours of learning is in the early part of the day. Some students are of the night-owl type, who have difficulty in getting up early but have productive hours in the night. There are students who find it fun

## test2.dat

```

title:Test 2: Some Introductory Concepts in Statics
loc:http://enr.uark.edu/~icj/webtest
# 1 (Note: Answers contain several numbers with HTML tags.)
question:(5 Points) Rounding the number 0.03065 to three significant
digits, we get
answer:+0.0306;0.03;0.0307;3.065 x 10<sup>-2</sup>;0.031
tip:Right choice!;Do leading zeros count as significant digits?;When
the first digit dropped is 5 that is not followed by any nonzero digit,
should the last digit retained always be increased by 1?;How many
significant digits does the number 3.065 x 10<sup>-2</sup> have?;Are
decimal places the same as significant digits?
explanation:When the first digit dropped is 5 that is not followed by
any nonzero digit, the last digit retained is such that it remains, or
is increased by 1 to become, an even digit.
points:5
&
# 2 (Note: Answers contain several terms.)
question:(5 points) The base unit for mass in SI is
answer:+kilogram;slug;gram;newton;pound-mass
tip:Right choice!;Is slug a unit in SI?;Is gram or kilogram a secondary
unit in SI?;Is newton a unit for force or mass?;Is pound-mass a unit in
SI?
explanation:The kilogram is the base unit for mass in SI. It is the
only base unit with a prefix.
points:5
&
# 3 (Note: Answers contain several statements with HTML tags.)
question:(10 points) One newton is defined as
answer:the weight of a 1-kg mass;the weight of a 1-slug mass;the net
force required to accelerate a mass of 1 kg at 9.80665
m/s<sup>2</sup>;the net force required to accelerate a mass of 1 kg at
1 m/s<sup>2</sup>;the net force required to accelerate a mass of 1 slug
at 1 ft/s<sup>2</sup>
tip:A 1-kg mass on the surface of the earth weighs about 9.81 N.;A 1-
slug mass on the surface of the earth weighs about 32.2 lb.;It takes a
net force of 9.80665 N to accelerate a mass of 1 kg at 9.80665
m/s<sup>2</sup>;Right choice!;It takes a net force of 32.2 lb to
accelerate a mass of 1 slug at 1 ft/s<sup>2</sup>.
explanation:One newton is defined as the net force required to
accelerate a mass of 1 kg at 1 m/s<sup>2</sup>.
points:10
&
# 4 (Note: Question contains a figure, answers contain several
equations.)
question:(10 points) Which of the following equations correctly
relates the vectors <b>F</b>, <b>P</b>, and <b>Q</b>, as shown?
picture:http://enr.uark.edu/~icj/webtest/t2figs/fig2.4q.gif
answer:<b>F</b> + <b>Q</b> = <b>P</b>;<b>P</b> + <b>Q</b> =
<b>F</b>;<b>P</b> + <b>F</b> = <b>Q</b>;<b>F</b> <font face =
symbol><font size=-1>-</font></font> <b>Q</b> = <b>P</b>;<b>F</b> <font
face=symbol><font size=-1>-</font></font> <b>P</b> = <b>Q</b>
tip:Are <b>Q</b> and <b>F</b> arranged in tip-to-tail fashion according
to the triangle rule to produce a sum equal to <b>P</b>;Are <b>P</b>
and <b>Q</b> arranged in tip-to-tail fashion according to the triangle
rule to produce a sum equal to <b>F</b>;Right choice!;Is <b>F</b> =
<b>P</b> + <b>Q</b> according to the triangle rule? If so, your choice
would be correct.;Is <b>F</b> = <b>P</b> + <b>Q</b>? If so, your choice
would be correct.
explanation:When two vectors are drawn to scale in tip-to-tail fashion,
the vector drawn from the tail of the first vector to the tip of the
second vector gives the resultant of those two vectors.
points:10
&
# 5 (Note: Question contains a figure, answers contain several
figures.)
question:(10 points) Three vectors <b>F</b>, <b>P</b>, and <b>Q</b>
are shown. Which figure contains the vector <b>R</b> that correctly
represents the resultant of the three vectors shown?
picture:http://enr.uark.edu/~icj/webtest/t2figs/fig2.5q.gif
picture:http://enr.uark.edu/~icj/webtest/t2figs/fig2.5a.gif;http://enr.
uark.edu/~icj/webtest/t2figs/fig2.5b.gif;http://enr.uark.edu/~icj/w
ebtest/t2figs/fig2.5c.gif;http://enr.uark.edu/~icj/webtest/t2figs/fig2
.5d.gif
answer:pic1;pic2;pic3;+pic4
tip:Are the three given vectors arranged in tip-to-tail fashion
according to the polygon rule?;Are the three given vectors arranged in
tip-to-tail fashion according to the polygon rule?;Is the resultant
drawn from the tail of the first vector to the tip of the last
vector?;Right choice!
explanation:When the three vectors <b>F</b>, <b>P</b>, and <b>Q</b> are
drawn to scale in tip-to-tail fashion, the vector <b>R</b> drawn from
the tail of the first vector <b>F</b> to the tip of the last vector
<b>Q</b>, as shown in the figure, gives the resultant of those three
vectors.
points:10
&

```

Figure 10. test2.dat.

Tag Name	Purpose	Requirement	Remarks
<b>title:</b>	To list the <i>title</i> of the interactive web-based test	<b>Required</b>	The title will appear in a second-level heading (<H2>) at the top of the test page.
<b>loc:</b>	To indicate the <i>location</i> of the directory containing the general program files	<b>Required</b>	The files testrad.cgi, ans1.cgi, and ans2.cgi are located in the directory indicated by it.

Table 1. Tags for Listing Title and Location . (See the file Test 2.dat.)

Tag Name	Purpose	Requirement	Remarks
<b>question:</b>	To indicate the credit points, if appropriate, and to list the non-graphic portion of the statement of the question (See remarks for the tag <b>points:</b> in this table.)	<b>Required</b>	Credit points may be indicated in parentheses at the start of the question statement. All appropriate HTML tags may be used in the data file <b>test#.dat</b> .
<b>qpicture:</b>	To list the web site of the picture or graphic item to be displayed as part of the question statement	Optional	Generally, the picture here is used to enhance the question statement. Most browsers accept pictures in GIF or JPEG format.
<b>apicture:</b>	To list the several web sites, separated by <b>semicolons</b> , of the several pictures or graphic items to be displayed as prospective answers	Optional	If this tag is used, the pictures listed under this tag, instead of the items listed under <b>answer:</b> , will be displayed.
<b>answer:</b>	To list the several non-graphic prospective answers, separated by <b>semicolons</b> , where the correct one, or the dummy correct one, must be preceded by a + sign	<b>Required</b>	If <b>apicture:</b> exists, items listed under <b>answer:</b> become dummy ones, but the + sign is still needed to indicate that the corresponding one under <b>apicture:</b> is the correct answer.
<b>tip:</b>	To offer appropriate tips, separated by <b>semicolons</b> , <i>corresponding</i> to the prospective answers that may be chosen by students, without giving them answers	Optional	Appropriate tips will timely help students learn new concepts when they click the SUBMIT button to see Comments and Test Score. (See figure 4.)
<b>explanation:</b>	To provide in the key to the test explanations of the reason, rule, law, or principle to be applied to reach the correct choice of answer to the current question	Optional	The explanations for correct choices in the test are given when students choose to click on the word <u>here</u> , two lines below the test score.
<b>points:</b>	To specify <i>internally</i> the credit points to be earned by the student for answering the question correctly (Credit points are indicated to the students under <b>question:</b> .)	Optional	If <b>points:</b> is omitted, the question is assumed to be worth 1 credit point. Thus, this tag is not needed if all questions are worth the same.
<b>&amp;</b>	To signal the end of data for a given question in the test	<b>Required</b>	The ampersand (&, without colon) serves as a delimiter for each question.

Table 2. Tags for Creating a Question . (See the file test2.dat.)

and challenging to interact with a computer and to learn from it at their own pace and in a time of their choice. Since computers are not persons, students are less likely to feel embarrassed to be initially given a low test score. The questions in each retake of a web-based test involve the same concepts to be mastered; thus, there is little uncertainty and much more learning for the students.

- To allow instructors to create teaching material of lasting value and to save overall efforts of teaching any size classes over the long run. A well-developed module for interactive web-based test can be improved or enriched over time, and it is there once it is done. Efficient teaching with less effort will be realized over time, and the instructor can use the time saved for other productive scholarly activities.

## B. Issues

The issues with web-based tests may likely arise when one tries to use them for replacement of conventional tests. The use of passwords alone could not solve the problem associated with cheating by students. The identity of the student taking a web-based test will require a more challenging and well thought-out solution. Perhaps, a testing center with proctors, as in distance education, may offer a viable solution for problems associated with cheating.

Any server that supports CGI scripts and PERL can be used to run the software presented in this paper. As the developed modules for web-based tests are kept in an account of a web server, the system administrator will undoubtedly be involved in ensuring security of all the files.

## VII. CONCLUDING REMARKS

This paper presents a basic yet versatile software that will enable interested beginning instructors to readily create modules for interactive web-based tests on virtually any subject. The software is written using PERL and CGI scripts to manipulate inputs, and it is user-friendly. The software is segmented into five related program files. For quick development of interactive on-line testing and learning on the WWW, one can directly modify the two template files test.html and test2.dat, and simply utilize the three general program files testrad.cgi, ans1.cgi, and ans2.cgi, which need no changes. Sample web pages providing an overview of the interactive on-line testing and learning have been included. The benefits and issues associated with interactive web-based tests have been discussed.

Web publishing on the Internet is fast becoming a powerful tool to provide an alternative mode in education. The use of well-developed web publishing packages will certainly play an important role in education in the coming new century. For a try out of interactive web-based tests, visit the gateway page at the location <http://engr.uark.edu/~icj/webtest/test.html>.

To download the software used in creating Test 1 and Test 2, simply click the name of the zipped file webtest.zip on the web page at <http://engr.uark.edu/~icj/webtest/>. After unzipping webtest.zip to a WWW accessible directory in a computer account at a local server, one should correspondingly change the *web addresses* (locations) contained in the files test.html and test#.dat. Note that each server could have its particular protocol for setting up the software. Therefore, additional assistance can come from the system administrator of the local server. It is our hope and pleasure to share our easy-to-use software with other educational professionals who are being encouraged to utilize web publication to enhance education. Many colleagues will surely report further innovations of web-based education in the future.

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## APPENDIX A: PROGRAM FILE: testrad.cgi

```
#!/usr/local/bin/perl
#      Filename: testrad.cgi
print ("content-Type: text/html\n\n");
print("<HEAD><TITLE>Interactive W0000eb-Based Tests</TITLE></HEAD>\n");
print("<BODY BGCOLOR=\"#FFF8DC\">");
#      OPEN THE INPUT FILE CONTAINING THE TEST INFORMATION
$pass="$ENV{PATH_INFO}";$number="$ENV{PATH_TRANSLATED}";
($file,$trash)=split(/\//number/,$number);
($passit,$trash)=split(/\//number/,$pass);
$passit=~ s/^\//g;
open(MYFILE,$file)|| print "<h3>Error: Can't open file.</h3>";
$k=0;$ap=0;$qp=0;$rand=0;while(<MYFILE>){
#      LOOK FOR COMMENTS AND IGNORE THEM
$in_line=$_;if($in_line =~ /\#/) { } else{
#      LOOK FOR THE TITLE AND PRINT IT
if($in_line =~ /\title:/{ $in_line=~ s/\title://g;
print("<h2>$in_line</h2>");
print "<b>Instruction:</b> Click on a radio button to choose the best item, as listed, for each of the following. Then, click the SUB-
MIT button.<br>"} else{
#      LOOK FOR THE LOCATION OF DIRECTORY CONTAINING CGI FILES
if($in_line =~ /\loc:/{ $in_line=~ s/\loc://g;$loc=$in_line; chop($loc);}
#      LOOK FOR THE QUESTION
if($in_line =~ /\question:/{ $in_line=~ s/\question://g;$question=$in_line;}
#      LOOK FOR THE QUESTION PICTURE
if($in_line =~ /\qpicture:/{ $in_line=~ s/\qpicture://g;$qp= $in_line;$qp=1;}
#      LOOK FOR THE ANSWERS
if($in_line =~ /\answer:/{ $in_line=~ s/\answer://g;$ans = $in_line;}
#      LOOK FOR THE ANSWER RELATED PICTURES
if($in_line =~ /\apicture:/{ $in_line=~ s/\apicture://g;$apic = $in_line;$ap=1;}
#      LOOK FOR THE TIPS (do nothing with them)
if($in_line =~ /\tip:/{ $in_line=~ s/\tip://g;$tip = $in_line;}
#      LOOK FOR THE EXPLANATION (do nothing with it)
if($in_line =~ /\explanation:/{ $in_line=~
s/\explanation://g;$explain=$in_line;}
if($in_line =~ /\&/){
#      PRINT THE QUESTION AND PICTURE (IF ONE IS PROVIDED)
print ('<FORM METHOD = "post" ACTION = "$loc/' ans1.cgi/' $passit,'">');
print "<hr> <p>",$k+1," &nbsp; &nbsp; ", $question," <br> </p>"; if($qp eq 1){print ' <br> <br>';}
#      PARSE THE ANSWERS AND PICTURES (IF PROVIDED)
@answer=split (/ / , $ans); foreach $i (0 .. $#answer) {
#      TAKE OUT THE + SIGN FROM THE CORRECT ANSWER
if ($answer[$i] =~ /\+/{ $answer[$i] =~ s/\+//g;}}
if($ap eq 1){@apict=split(/ /,$apic);
print "<br>";}
#      RANDOMIZE THE ANSWER ORDER
$j=-1;$l=$#answer;$number=rand($l);$h=substr($number,0,2); while($j++ < $l){
#      PUT ANSWER OPTIONS IN THE RADIO-BUTTON MENU
if($ap eq 1){
print '&nbsp; <input Type="radio" NAME="',$k,'" value="',$answer[$h],">
',' &nbsp; &nbsp; ';}
if($ap eq 0){
print '&nbsp; <input Type="radio" NAME="',$k,'" value="',$answer[$h],"> &nbsp; &nbsp; ', $answer[$h],'<br>';}
if($h le $l){ $h=$h+1;};if($h gt $l){ $h=$h-$l-1;};$k++; $qp=0;$ap=0;}}
#      CREATE THE SUBMIT AND RESET BUTTONS
print ('<hr><br><input type="submit" value="SUBMIT"> <input type="reset"
value="RESET"><br>');
print ('<input type="hidden" name=file value="',$file,'">');
```



```
# FINISH THE HTML DOCUMENT
print("</body> \n");print("</html> \n");
```



```

print "<p>",$k+1, " &nbsp; &nbsp; ", $question, " <br> </p>"; if($qp eq 1){
print ' <br> <br>';}
#      PARSE THE ANSWERS, TIPS, AND PICTURES (IF PROVIDED)
@answer=split(/;/, $ans); @tips=split(/;/, $tip); foreach $i (0..$#answer){
#      TAKE OUT THE + SIGN FROM THE CORRECT ANSWER
if($answer[$i] =~ /\^+\/){$ll=$i; $correct=$answer[$i]; $correct =~ s/\^+//g;
$answer[$i]=$correct;}} if($ap eq 1){@apict=split(/;/, $apic);
#      PRINT THE ANSWERS
if($ap eq 1){print "The correct choice is: &nbsp;  &nbsp; &nbsp; &nbsp; '}; print "<br> <br>";}
if($ap eq 0){print ("The correct choice is: &nbsp; ", $correct, " <br> <br>");}
print ("Explanation: &nbsp; &nbsp; ", $explain, " <br> <br> <hr>");
$k++; $qp=0; $ap=0;}}}}
#      FINISH THE HTML DOCUMENT
print ("</body> \n"); print ("</html> \n");

```