Diagnostic Test to Accompany

Mathematics Review Workbook for

COLLEGE PHYSICS

H. Thomas Hudson
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MATHEMATICS REVIEW WORKBOOK

FOR COLLEGE PHYSICS

H. Thomas Hudson

University of Houston

Little, Brown and Company
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INTRODUCTION

Many students who enroll in physics simply are not able to do the mathematics required for the problems and exercises. This is true even though many of these students have received passing grades in college level algebra and trigonometry courses. The table below summarizes how a class of 300 students from a general physics class performed on a test similar to the one at the end of this manual. All of the students had completed algebra and trigonometry and one-third had completed differential calculus.

Summary of Student Abilities in Various Mathematics Topics. Figures are percentages. 306 students were in the sample.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Do Not Understand</th>
<th>Need To Review</th>
<th>Understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing equations</td>
<td>7</td>
<td>29</td>
<td>64</td>
</tr>
<tr>
<td>Linear algebra - one unknown</td>
<td>11</td>
<td>39</td>
<td>50</td>
</tr>
<tr>
<td>Square roots of products and sums</td>
<td>5</td>
<td>18</td>
<td>77</td>
</tr>
<tr>
<td>Quadratic formula</td>
<td>10</td>
<td>52</td>
<td>38</td>
</tr>
<tr>
<td>Linear parametric equations</td>
<td>47</td>
<td>20</td>
<td>33</td>
</tr>
<tr>
<td>Parametric equations - one quadratic</td>
<td>40</td>
<td>24</td>
<td>36</td>
</tr>
<tr>
<td>Reading graphs</td>
<td>2</td>
<td>13</td>
<td>85</td>
</tr>
<tr>
<td>Sine functions</td>
<td>25</td>
<td>31</td>
<td>44</td>
</tr>
<tr>
<td>Cosine functions</td>
<td>28</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>Tangent functions</td>
<td>27</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td>Angles larger than 90°</td>
<td>36</td>
<td>42</td>
<td>22</td>
</tr>
<tr>
<td>Pythagorean theorem</td>
<td>14</td>
<td>32</td>
<td>54</td>
</tr>
<tr>
<td>Radian measure</td>
<td>22</td>
<td>26</td>
<td>52</td>
</tr>
<tr>
<td>Powers of ten</td>
<td>19</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>Working with symbols</td>
<td>14</td>
<td>32</td>
<td>54</td>
</tr>
<tr>
<td>Working with different orientations</td>
<td>17</td>
<td>27</td>
<td>56</td>
</tr>
<tr>
<td>Two-step problems</td>
<td>47</td>
<td>17</td>
<td>36</td>
</tr>
</tbody>
</table>

Placed in the position of teaching a class of students whose backgrounds are typical of those in the table, it would appear that the teacher must make an unpleasant choice between using class time for reviewing mathematics or going ahead with the physics material, whether or not students really follow the explanations and examples. Of course, either choice has a negative result. If class time is devoted to remediation, the time of those students who know the mathematics is wasted. If essential mathematical concepts are not reviewed, a significant number of students may fall behind and subsequently fail or drop the course.

Fortunately, there is a third alternative. Two researchers, R. H. Yeany and A. Miller, reviewed a number of published reports on remediation for science students at various levels of instruction. Based on a summary of the research literature at the time of their paper, they conclude that "Science students are capable [of attending] to their own remediation when provided with feedback from the diagnosis of achievement results." (R. H. Yeany and A. Miller, "Effects of diagnostic/remedial instruction on science
learning," Journal of Research in Science Teaching, 20, 19-26, 1983). The act of providing diagnostic information to students is the primary factor in the success of remediation efforts. Formal, organized remediation was no more effective than simply providing diagnostic information to students.

The test provided in this booklet is designed to serve as a tool for giving students diagnostic information on the basic mathematics used in a physics course. The problems and questions address 18 topics, and the answer sheet is organized in a way that will make it simple for students to identify the specific topics that they need to review or learn.

The test is constructed with 2 questions relating to each topic, making a total of 36 questions. Some problems are more complex than others, although none should take a fully prepared student more than one or two minutes to answer. It is recommended that 40 minutes be allocated for the test.

The test may be given in a class period or students may take it home. Although administering the test in a class period consumes valuable classroom time, it also sends a subtle but strong statement about the importance of a good working knowledge of the mathematics covered by the test. I require all students to take the test before I put them on my gradebook roll. The first class day is devoted to a short discussion of course details and to giving the test. Any student who is absent that first day must schedule to take it at a time other than a class period. No work is accepted for credit until students have completed the test. This communicates two messages: (1) The mathematics is very important, and (2) when a class is missed there will be an extra effort required. This might be called an extreme position, but I believe that the emphasis placed on prerequisite mathematics has been a significant factor in reducing the dropout rate by about half.

Research in physics education points toward a variety of factors that affect the success or failure of students in the study of physics. A number of independent studies have found a significant correlation between the purely mechanistic mathematics skills and knowledge (such as those in the following test) and performance in physics. While these studies indicate that there are other powerful factors that impact performance, fundamental knowledge in mathematics is, at the least, a necessary condition for success in physics. As the search goes on for all of the cognitive skills that greatly influence how students do in physics courses, we can use what we do know to help a significant number of our students now.

The following test is a second generation version of the original. The test addresses 19 separate topics and working with symbols. The solution sheet and the topic listing may be distributed after the test is completed.

H.T. Hudson
**HOOVER GOLF 2013 GIRL’S SCHEDULE**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TEAM</th>
<th>TEE TIME</th>
<th>BUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tue Aug 6</td>
<td>Warren JFK Invitational</td>
<td>8:30</td>
<td>6:45am</td>
</tr>
<tr>
<td></td>
<td>Candywood Golf Course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wed Aug 7</td>
<td>Jackson 8</td>
<td>9am</td>
<td>7:30am</td>
</tr>
<tr>
<td></td>
<td>Legends of Massillon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat Aug 10</td>
<td>*Villa Madonna Invitational</td>
<td>9am (SAT)</td>
<td>10am (FRI)</td>
</tr>
<tr>
<td></td>
<td>Covington, Kentucky</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tue Aug 13</td>
<td>Federal League Pre-Season</td>
<td>9am</td>
<td>7:30am</td>
</tr>
<tr>
<td></td>
<td>Tam O Shanter Dales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri Aug 16</td>
<td>Pickerington Invitational</td>
<td>9am (FRI)</td>
<td>4pm (THUR)</td>
</tr>
<tr>
<td></td>
<td>Turnberry Golf Club</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat Aug 24</td>
<td>Midwest Golf Classic</td>
<td>8am</td>
<td>DRIVE</td>
</tr>
<tr>
<td>Mon Aug 26</td>
<td>Walsh Jesuit Invitational</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tue Aug 27</td>
<td>Jackson dual</td>
<td>4pm</td>
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</tr>
<tr>
<td></td>
<td>Shady Hollow CC</td>
<td></td>
<td></td>
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<tr>
<td>Thur Aug 29</td>
<td>GlenOak dual</td>
<td>4pm</td>
<td>HOME</td>
</tr>
<tr>
<td></td>
<td>Arrowhead Golf Course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mon Sept 9</td>
<td>Central Catholic</td>
<td>4pm</td>
<td>2:45</td>
</tr>
<tr>
<td>Thur Sep 12</td>
<td>Boardman dual</td>
<td>4pm</td>
<td>HOME</td>
</tr>
<tr>
<td></td>
<td>Arrowhead Golf Club</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat Sep 14</td>
<td>Turkeyfoot Invitational</td>
<td>9am</td>
<td>7:15am</td>
</tr>
<tr>
<td></td>
<td>Turkeyfoot Golf Club</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wed Sep 18</td>
<td>Lake dual</td>
<td>4pm</td>
<td>HOME</td>
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<tr>
<td></td>
<td>Arrowhead Golf Course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thur Sep 19</td>
<td>Perry dual</td>
<td>4pm</td>
<td>2:45</td>
</tr>
<tr>
<td></td>
<td>Legends of Massillon</td>
<td></td>
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<tr>
<td>Sat Sept 21</td>
<td>Stark County Open</td>
<td>9am</td>
<td>7am</td>
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<tr>
<td></td>
<td>Elms Golf Course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tue Sept 24</td>
<td>McKinley dual</td>
<td>4pm</td>
<td>DRIVE</td>
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<tr>
<td></td>
<td>Edgewood Golf Course</td>
<td></td>
<td></td>
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<tr>
<td>Sat Sept 28</td>
<td>Federal League Post Season</td>
<td>9am</td>
<td>7am</td>
</tr>
<tr>
<td></td>
<td>Tannenhauf Golf Club</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DATES AND TIMES ARE SUBJECT TO CHANGE
WE WILL TRY TO SEND HOME ANY CHANGES IN WRITING
Coach Scott Snyder  330-704-8019
Coach Kevin Hinton 330-354-9430
We have set up a Twitter account to send out information regarding practices and schedules. This is an experiment this year to see how it works. Please let us know if you find this useful

@HooverGolf
1. What is the value of \( x \) in the expression
\[ x = p(p + q) + 4 \]
if \( p = -2 \) and \( q = 5 \)?
a. -2  b. -3  c. 4  d. -6  e. 18

2. Given \( x + 2 = 2(x - 3) \), what is the value of \( x \)?
a. 2  b. 3  c. 4  d. 6  e. 8

3. \[ \sqrt{15^2 - 9^2} = \]________.
a. 6  b. \( \sqrt{5} \)  c. 12  d. \( \sqrt{12} \)  e. \( \sqrt{35} \)

4. \( 3y^2 - 7y + 2 = 0 \). \( y = \)________.
a. \( 7/3 \) or \( 7/2 \)  b. \( 7/3 \) or \( -7/2 \)  c. \( -7/3 \) or \( 3/2 \)
d. 2 or -7  e. 2 or \( 1/3 \)

5. What is the value of \( x \) in the following equations?
\[ x + 4t = 2 \]
\[ 2x - 2 = t + 2 \]
a. -2/9  b. 2  c. 1/2  d. 4  e. 1/4

6. Find \( y \) as a function of \( x \) from the following equations.
\[ 2x - t = 2 \]
\[ y - 4 = 3t \]
a. \( y = 3x + 4 \)  b. \( y = 10 - 3x \)  c. \( y = 3x + 6 \)
d. \( y = 4 - 6x \)  e. \( y = 6x - 2 \)
7. Find \( z \) as a function of \( t \) from the following equations.

\[
\begin{align*}
12 + s &= t^2 \\
2s &= 3z
\end{align*}
\]

a. \( z = 3t^2 - 12 \)  \\
b. \( z = (2/3)t^2 - 8 \)  \\
c. \( z = (1/3)t^2 - 12 \)  \\
d. \( z = (2/3)t^2 + 24 \)  \\
e. \( z = 3t^2 + 6 \)

8. For the triangle illustrated, what is \( p \)?

\[
\begin{align*}
4 \quad &\quad 6 \quad \quad \quad p
\end{align*}
\]

a. \( \sqrt{2} \)  \\
b. 2  \\
c. \( \sqrt{10} \)  \\
d. 10  \\
e. \( \sqrt{20} \)

9. What is the slope of the line at \( x = 6 \)?

\[
\begin{align*}
a. & \quad 1 \\
b. & \quad 1.5 \\
c. & \quad 0.7 \\
d. & \quad -1 \\
e. & \quad 6
\end{align*}
\]

10. \[
\frac{12 \times 10^8}{2 \times 10^{-2}} = \]

a. \( 6 \times 10^{-4} \)  \\
b. \( 10 \times 10^{10} \)  \\
c. \( 10 \times 10^{-10} \)  \\
d. \( 6 \times 10^{10} \)  \\
e. \( 10 \times 10^{6} \)

11. If the angle \( A = 4\pi/6 \) radians, what is the value of \( A \) in degrees?

a. 600  \\
b. 1200  \\
c. 900  \\
d. 450  \\
e. 2100

12. A mother is five years more than twice as old as her daughter. The combined ages of mother and daughter totals 41 years. How old is the mother?

a. 18 years  \\
b. 21 years  \\
c. 23 years  \\
d. 29 years  \\
e. 36 years
13. \( \frac{3}{14} + \frac{7}{6} = \) 
   a. 29/21  
   b. 21/20  
   c. 10/21  
   d. 18/49  
   e. 5/21

14. What is the value of \( x \) in the equation \( x^2 - 5x - 3 = 0 \)?
   a. \((-1 \pm \sqrt{14})/10\)  
   b. \((3 \pm \sqrt{28})/2\)  
   c. \((5 \pm \sqrt{37})/2\)  
   d. \((-3 \pm \sqrt{22})/6\)  
   e. \((1 \pm \sqrt{23})/7\)

15. Given \( a = -2, b = 3, c = -5 \), what is the value of \( a(b - c) + bc^2 \)?
   a. -91  
   b. -79  
   c. 79  
   d. 71  
   e. 59

16. Solve for \( q \) in the following expression, treating \( A, B \) and \( C \) as constants: \( A(q - B) = Bq - C \).
   a. \( q = (B - C)/(A + B) \)  
   b. \( q = (AB - C)/(A - B) \)  
   c. \( q = (B + C)/AB \)  
   d. \( q = (A + B)/(AB - C) \)  
   e. \( q = (A + B)/(B - C) \)

17. Solve for \( y \) as a function of \( x \) from the following equations, treating \( R, S, \) and \( T \) as constants.
   \[ Rx - St = T \]
   \[ y = S(St + T) \]
   a. \( y = SRx \)
   b. \( y = S^2Rx + ST \)
   c. \( y = S^2Rx - 2ST \)
   d. \( y = SRx - ST \)
   e. \( y = (SRx - S^2 - ST^2)/T \)

18. Given \( ap = bt^2 \) and \( bq = at \), where \( a \) and \( b \) are constants, what is \( q \) as a function of \( p \)?
   a. \( q = p\sqrt{b/a} \)
   b. \( q = (a/b)\sqrt{ap/b} \)
   c. \( q = p^2\sqrt{a/b} \)
   d. \( q = p \)
   e. \( q = \sqrt{ap/b} \)

19. What is the intercept (i.e., the value of \( x \) when \( y = 0 \)) of the straight line through the points \((x = 6, y = -1)\) and \((x = 3, y = 2)\)?
   a. 3  
   b. 5  
   c. -3  
   d. -5  
   e. 1
20. What is the length of the unknown side of the right triangle illustrated in terms of $p$ and $q$?

a. $\sqrt{q} - \sqrt{p}$

b. $\sqrt{p} - \sqrt{q}$

c. $\sqrt{p^2 + q^2}$

d. $\sqrt{p^2 - q^2}$

e. $\sqrt{q^2 - p^2}$

21. How many radians in $210^0$?

a. $\frac{5\pi}{12}$

b. $\frac{7\pi}{12}$

c. $\frac{5\pi}{7}$

d. $\frac{6\pi}{7}$

e. $\frac{7\pi}{6}$

22. $(6.5 \times 10^{-4}) - (1.37 \times 10^{-3}) = \underline{\quad}$.

a. $5.1 \times 10^{-3}$

b. $5.4 \times 10^{-3}$

c. $5.1 \times 10^{-4}$

d. $-7.2 \times 10^{-4}$

e. $-6.4 \times 10^{-4}$

23. $\frac{a + b}{a} + \frac{b - a}{b} = \underline{\quad}$.

a. 2

b. $(b^2 + 2ab - a^2)/ab$

c. $2/ab$

d. $(a^2 + 2ab + b^2)/2ab$

e. $2a/b$

24. Ann and Sue are painters. A certain job will require 15 hours if Ann works alone but only six hours if Ann and Sue work together. How long will it take Sue, working alone, to complete the job?

a. 4.5 hours

b. 8 hours

c. 9 hours

d. 10 hours

e. 11.5 hours

25. $\cos 300^0 = \underline{\quad}$.

a. $+ \cos 60^0$

b. $- \cos 60^0$

c. $+ \cos 30^0$

d. $- \cos 30^0$

e. none of the above

26. $(4 \times 10^6) \times (3 \times 10^{-4}) = \underline{\quad}$.

a. $12 \times 10^{-24}$

b. $1.3 \times 10^{10}$

c. $0.75 \times 10^{10}$

d. 75

e. 1200
27. Solve for \( x \) in the equation below, treating \( p \), \( q \) and \( r \) as constants:

\[
qx^2 - rx + p = 0
\]

a. \((-r \pm \sqrt{r^2 - 4pq})/2q\)  
   b. \((-q \pm \sqrt{q^2 - 4rp})/2q\)  
   c. \((p \pm \sqrt{p^2 - 4qr})/2p\)  
   d. \((r \pm \sqrt{r^2 - 4pq})/2q\)  
   e. \((-p \pm \sqrt{p^2 - 4rp})/2r\)

28. \( \cos \theta = \ldots \).  

a. \(a/c\)  
   b. \(c/a\)  
   c. \(b/c\)  
   d. \(a/b\)  
   e. \(b/a\)

29. What are the values of \( x \) in the expression below?

\[
2x^2 - 3ax - 2a^2 = 0
\]

a. \(2a; a/3\)  
   b. \(2a; -a/2\)  
   c. \(2a; -a/3\)  
   d. \(-3a; -2a\)  
   e. \(3a; a/2\)

30. Solve for \( y \) in the following equations.

\[
\begin{align*}
2y - 5 &= z \\
y - 2z &= 1
\end{align*}
\]

a. \(1\)  
   b. \(2\)  
   c. \(3\)  
   d. \(4\)  
   e. \(5\)

31. \[
\frac{xy}{z^2} + \frac{zx}{zy} = \ldots \]

a. \(y/z\)  
   b. \(x/z^2\)  
   c. \((xy + z^2x^2)/z^2y\)  
   d. \((xy + z)/(z^2x + zy)\)  
   e. \((y^2 + z^2x)/z^2y\)

32. \(3.48 \times 10^5 + 1.26 \times 10^4 = \ldots \).

a. \(3.6 \times 10^5\)  
   b. \(4.74 \times 10^5\)  
   c. \(3.6 \times 10^4\)  
   d. \(1.6 \times 10^5\)  
   e. \(1.6 \times 10^4\)
33. \( \tan \theta = \) 
   a. \( \frac{x}{z} \)  
   b. \( \frac{x}{y} \)  
   c. \( \frac{z}{y} \)  
   d. \( \frac{y}{z} \)  
   e. \( \frac{y}{x} \)  

34. \( \sqrt{9^2 + 6^2} = \) 
   a. \( \sqrt{9} + \sqrt{6} \)  
   b. \( \sqrt{15} \)  
   c. \( \sqrt{34} \)  
   d. \( \sqrt{117} \)  
   e. 15  

35. \( \frac{2x - y}{x} + \frac{x + y}{y} = \) 
   a. \( \frac{3x}{y} \)  
   b. \( \frac{(x^2 + 3xy - y^2)}{xy} \)  
   c. \( \frac{(2x^2 - y^2)}{xy} \)  
   d. \( 2x^2 + y^2 - 3xy \)  
   e. \( 2 - y + x \)  

36. \( \tan 100^\circ = \) 
   a. \( \tan 100^\circ \)  
   b. -\( \tan 100^\circ \)  
   c. \( \tan 80^\circ \)  
   d. -\( \tan 80^\circ \)  
   e. none of the above  

37. What is the (approximate) slope of the curve at \( x = 11 \)?  
   a. -0.4  
   b. +1  
   c. +2  
   d. -0.6  
   e. -1  

38. What is the value of \( q \) when \( x = 0 \) on the line that goes through the points \( (x = 3, q = 10) \) and \( (x = -3, q = -2) \)?  
   a. 2  
   b. 4  
   c. 13  
   d. 17  
   e. -17
Answers to Diagnostic Test

The answers to the diagnostic test are given below. Circle the questions you answered incorrectly and then refer to the diagnostic that follows.

1. a. -2
2. e. 8
3. c. 12
4. e. 2 or 1/3
5. b. 2
6. e. \(y = 6x - 2\)
7. b. \(z = (2/3)t^2 - 8\)
8. e. \(\sqrt{20}\)
9. c. 0.7
10. d. 6 \(\times\) 10\(^1\)0
11. b. 1200
12. d. 29 years
13. a. 29/21
14. c. \((5 + \sqrt{37})/2\)
15. e. 59
16. b. \((AB - C)/(A - B)\)
17. a. \(y = SRx\)
18. b. \(q = (a/b)\sqrt{ap/b}\)
19. b. 5
20. d. \(\sqrt{p^2 - q^2}\)
21. e. \(7\pi/6\)
22. d. -7.2 \(\times\) 10\(^{-4}\)
23. b. \((b^2 + 2ab - a^2)/ab\)
24. d. 10 hours
25. a. + cos 60°
26. e. 1200
27. d. \(\left(r \pm \sqrt{r^2 - 4pq}\right)/2q\)
28. b. c/a
29. b. 2a; -a/2
30. c. 3
31. e. \((y + z^2x)/z^2y\)
32. a. 3.6 \(\times\) 10\(^5\)
33. d. \(y/z\)
34. d. \(\sqrt{117}\)
35. b. \((x^2 + 3xy - y^2)/xy\)
36. d. - tan 80°
37. d. -0.6
38. b. 4
Diagnostic for Math Test

Each of the topics below refers to questions from the preceding test. Circle each question that you answered incorrectly.

You need to learn those topics for which you missed both questions. You probably understand those topics for which you correctly answered both questions. However, you should keep in mind that the time you were allowed may or may not have influenced you as you took the test. If there were questions that required more than a minute or two to answer, you need to practice that topic.

Finally, you need to review and practice with topics for which you correctly answered only one question.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Substitution</td>
<td>1 15</td>
</tr>
<tr>
<td>2. Clearing equations</td>
<td>2 16</td>
</tr>
<tr>
<td>3. Square roots</td>
<td>3 34</td>
</tr>
<tr>
<td>4. Factoring quadratic equations</td>
<td>4 29</td>
</tr>
<tr>
<td>5. Two equations-two unknowns</td>
<td>5 30</td>
</tr>
<tr>
<td>6. Linear parametric equations</td>
<td>6 17</td>
</tr>
<tr>
<td>7. Parametric equations-one a quadratic</td>
<td>7 18</td>
</tr>
<tr>
<td>8. Pythagorean theorem</td>
<td>8 20</td>
</tr>
<tr>
<td>9. Graphs</td>
<td>9 37</td>
</tr>
<tr>
<td>10. Powers of ten multiplication and division</td>
<td>10 26</td>
</tr>
<tr>
<td>11. Degrees to radians</td>
<td>11 21</td>
</tr>
<tr>
<td>12. Word problems</td>
<td>12 24</td>
</tr>
<tr>
<td>13. Adding fractions</td>
<td>13 31</td>
</tr>
<tr>
<td>14. Quadratic formula</td>
<td>14 27</td>
</tr>
<tr>
<td>15. Slope and intercept of line</td>
<td>19 38</td>
</tr>
<tr>
<td>16. Powers of ten addition and subtraction</td>
<td>22 32</td>
</tr>
<tr>
<td>17. Trigonometric functions of large angles</td>
<td>25 36</td>
</tr>
</tbody>
</table>
In addition to math knowledge, the following pairings suggest that you may have difficulty working with symbols.

2 correct and 16 incorrect
14 correct and 27 incorrect
4 correct and 29 incorrect
6 correct and 17 incorrect