Diagnostic Test to Accompany

Mathematics Review Workbook

for

COLLEGE PHYSICS

H. Thomas Hudson

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MATHEMATICS REVIEW WORKBOOK FOR COLLEGE PHYSICS

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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.

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

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 administrating 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

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

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

DIAGNOSTIC TEST

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. $\sqrt{6}$ c. 12 d. $\sqrt{12}$ e. $\sqrt{135}$

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.

$12 + s = t^2$

$2s = 3z$

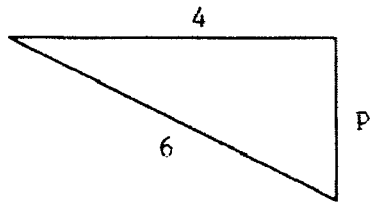
a. $z = 3t^2 - 12$ b. $z = (2/3)t^2 - 8$ c. $z = (1/3)t^2 - 12$

d. $z = (2/3)t^2 + 24$ e. $z = 3t^2 + 6$

8. For the triangle illustrated, what is p?

a. $\sqrt{2}$ b. 2 c. $\sqrt{10}$

d. 10 e. $\sqrt{20}$



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

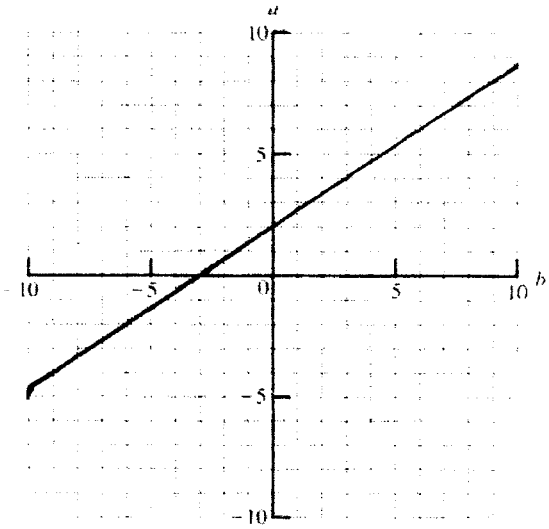
a. 1

b. 1.5

c. 0.7

d. -1

e. 6



10. $\frac{12 \times 10^8}{2 \times 10^{-2}}$ = _____.

a. 6×10^{-4} b. 10×10^{10} c. 10×10^{-10}

d. 6×10^{10} e. 10×10^6

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

a. 60° b. 120° c. 90° d. 45° e. 210°

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?

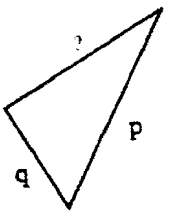
a. $q = p\sqrt{b/a}$ b. $q = (a/b)\sqrt{ap/b}$ c. $q = p^2\sqrt{a/b}$

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

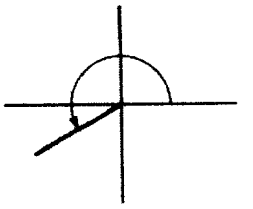
20. What is the length of the unknown side of the right triangle illustrated in terms of p and q?



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^o?



a. $5\pi/12$ b. $7\pi/12$ c. $5\pi/7$

d. $6\pi/7$ e. $7\pi/6$

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

a. 5.1×10^{-3} b. 5.4×10^{-3} c. 5.1×10^{-4}

d. -7.2×10^{-4} e. -6.4×10^{-4}

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

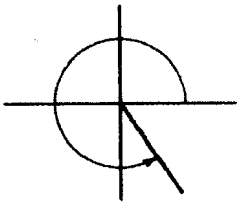
a. 2 b. $(b^2 + 2ab - a^2)/ab$ c. $2/ab$

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^o = _____.



a. + cos 60^o b. - cos 60^o
c. + cos 30^o d. - cos 30^o
e. none of the above

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

a. 12×10^{-24} b. 1.3×10^{10} c. 0.75×10^{10}

d. 75 e. 1200

27. Solve for x in the equation below, treating p, q and r as constants:

$$qx^2 - rx + p = 0$$

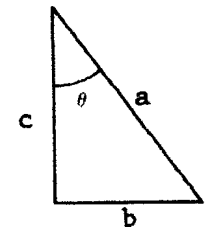
a. $(-r \pm \sqrt{q^2 + 4rp})/2q$ b. $(-q \pm \sqrt{r^2 - 4pq})/2q$

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

e. $(-p \pm \sqrt{q^2 - 4rp})/2r$

28. Cos θ = _____.

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.

$$2y - 5 = z$$
$$y - 2z = 1$$

a. 1 b. 2 c. 3 d. 4 e. 5

31. $\frac{xy}{z^2x} + \frac{zx}{zy}$ = _____.

a. y/z b. x/z^2 c. $(xy + z^2x^2)/z^2y$

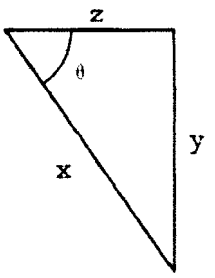
d. $(xy + z)/(z^2x + zy)$ e. $(y^2 + z^2x)/z^2y$

32. $3.48 \times 10^5 + 1.26 \times 10^4$ = _____.

a. 3.6×10^5 b. 4.74×10^5 c. 3.6×10^4

d. 1.6×10^5 e. 1.6×10^4

33. Tan θ = _____.



a. x/z b. x/y
c. z/y d. y/z
e. y/x

34. $\sqrt{9^2 + 6^2}$ = _____.

a. $\sqrt{9} + \sqrt{6}$ b. $\sqrt{15}$ c. $\sqrt{54}$ d. $\sqrt{117}$ e. 15

35. $\frac{2x - y}{x} + \frac{x + y}{y}$ = _____.

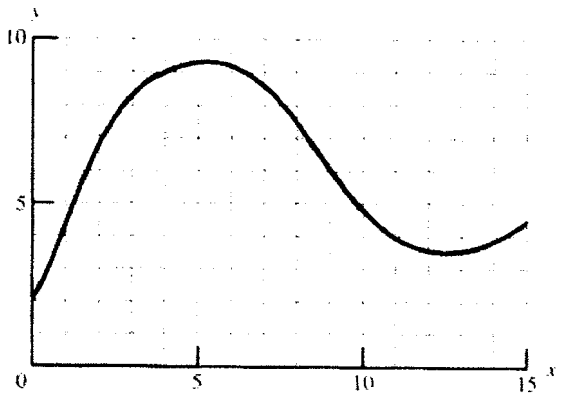
a. 3x/y b. $(x^2 + 3xy - y^2)/xy$ c. $(2x^2 - y^2)/xy$

d. $2x^2 + y^2 - 3xy$ e. 2 - y + x

36. Tan 100^o = _____.

a. tan 10^o b. - tan 10^o
c. tan 80^o d. - tan 80^o
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. 6×10^{10}
11. b. 120^o
12. d. 29 years
13. a. 29/21
14. c. $(5 \pm \sqrt{37})/2$
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. -7.2×10^{-4}
23. b. $(b^2 + 2ab - a^2)/ab$
24. d. 10 hours
25. a. $+ \cos 60^o$
26. e. 1200
27. d. $(r \pm \sqrt{r^2 - 4pq})/2q$
28. b. c/a
29. b. 2a; -a/2
30. c. 3
31. e. $(y + z^2x)/z^2y$
32. a. 3.6×10^5
33. d. y/z
34. d. $\sqrt{117}$
35. b. $(x^2 + 3xy - y^2)/xy$
36. d. $-\tan 80^o$
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.

Topic		Questions	
1.	Substitution	1	15
2.	Clearing equations	2	16
3.	Square roots	3	34
4.	Factoring quadratic equations	4	29
5.	Two equations-two unknowns	5	30
6.	Linear parametric equations	6	17
7.	Parametric equations-one a quadratic	7	18
8.	Pythagorean theorem	8	20
9.	Graphs	9	37
10.	Powers of ten multiplication and division	10	26
11.	Degrees to radians	11	21
12.	Word problems	12	24
13.	Adding fractions	13	31
14.	Quadratic formula	14	27
15.	Slope and intercept of line	19	38
16.	Powers of ten addition and subtraction	22	32
17.	Trigonometric functions of large angles	25	36

Topic	Questions	
18. Trigonometric functions	28	33
19. Canceling	23	35

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