

# Mathematics pretest may partially predict students' physics course performance

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Supported in part by NSF DUE #1504986 and #1914712

## Overview

We have given diagnostic tests covering pre-college mathematics to over 7000 introductory physics students:

- Error rates were large enough to suggest that math difficulties can interfere with course performance;
- Preliminary findings suggest that very high or low math pre-test scores may provide indications of ultimate physics course performance

What is the length of side  $x$ ?

A.  $y \cos(2^\circ)$  B.  $y \sin(2^\circ)$  C.  $y \tan(2^\circ)$  D.  $y / \cos(2^\circ)$  E.  $y / \sin(2^\circ)$  F.  $y / \tan(2^\circ)$  G.  $\cos(2^\circ)/y$  H.  $\sin(2^\circ)/y$  I.  $\tan(2^\circ)/y$  J.  $\sqrt{y^2 + 2}$  K.  $\sqrt{y^2 - 2}$  L.  $y/2$

(There may be more than one correct answer, but please select only ONE answer.)

What is the value of  $\theta$ ?

A.  $\cos(3/6)$  B.  $\sin(3/6)$  C.  $\tan(3/6)$  D.  $\cos^{-1}(3/6)$  E.  $\sin^{-1}(3/6)$  F.  $\tan^{-1}(3/6)$  G.  $30^\circ$  H.  $45^\circ$  I.  $60^\circ$  J.  $27^\circ$  K.  $3/6$  L.  $0.524$

(There may be more than one correct answer, but please select only ONE answer.)

$\cos(\theta) = ?$

A. 0 B. 1 C. undefined D. 0.707 E. 0.894

(There may be more than one correct answer, but please select only ONE answer.)

Solve for  $\theta$ .

$\gamma\theta + \eta = 3\theta + \omega$

A.  $\frac{\eta + \omega}{\gamma - \lambda}$  B.  $\frac{\eta - \omega}{\lambda - \gamma}$  C.  $\frac{\gamma - \lambda}{\omega - \eta}$  D.  $\frac{\lambda - \gamma}{\eta - \omega}$  E.  $\frac{\eta - \omega}{\gamma - \lambda}$  F.  $\frac{\omega - \eta}{\gamma - \lambda}$  G.  $\frac{\eta - \omega}{\gamma - \lambda}$  H.  $\frac{\omega - \eta}{\gamma + \lambda}$  I.  $\frac{\eta - \omega + \gamma}{\lambda}$  J.  $\frac{\omega - \eta + \lambda}{\gamma}$

(There may be more than one correct answer, but please select only ONE answer.)

What is the slope of the graph below?

A.  $\frac{1}{3}$  m/s because the object moves 1 meter in 3 seconds.  
 B.  $\frac{1}{3}$  m/s because the line rises 1 box while it goes 3 boxes in the horizontal direction.  
 C.  $\frac{2}{3}$  m/s because the object moves 2 meters in 3 seconds.  
 D.  $\frac{2}{3}$  m/s because the line rises 2 boxes while it goes 3 boxes in the horizontal direction.

(There may be more than one correct answer, but please select only ONE answer.)

$\left(\frac{a}{3}\right)^3 = ?$

A.  $\frac{a^3}{3}$  B.  $\frac{a}{27}$  C.  $\frac{a^3}{27}$

(There may be more than one correct answer, but please select only ONE answer.)

$\frac{a/b}{c^2/d} = ?$

A.  $\frac{ac^2}{bd}$  B.  $\frac{ad}{bc^2}$  C.  $\frac{bd}{ac^2}$  D.  $\frac{bc^2}{ad}$

(There may be more than one correct answer, but please select only ONE answer.)

$2\left(\frac{3}{4}\right) = ?$

A.  $\frac{6}{8}$  B.  $\frac{12}{8}$  C.  $\frac{3}{8}$  D.  $\frac{3}{2}$  E.  $\frac{3}{4}$

(There may be more than one correct answer, but please select only ONE answer.)

(a) Area of the circle = ?

A.  $8\pi \text{ cm}^2$  B.  $16\pi \text{ cm}^2$  C.  $32\pi \text{ cm}^2$  D.  $64\pi \text{ cm}^2$  E.  $128\pi \text{ cm}^2$  F.  $8\pi \text{ cm}$  G.  $16\pi \text{ cm}$  H.  $32\pi \text{ cm}$  I.  $64\pi \text{ cm}$  J.  $128\pi \text{ cm}$  K.  $8\pi \text{ cm}^2$  L.  $16\pi \text{ cm}^2$  M.  $32\pi \text{ cm}^2$  N.  $64\pi \text{ cm}^2$  O.  $128\pi \text{ cm}^2$  P.  $8\pi \text{ cm}$  Q.  $16\pi \text{ cm}$  R.  $32\pi \text{ cm}$  S.  $64\pi \text{ cm}$  T.  $128\pi \text{ cm}$

(There may be more than one correct answer, but please select only ONE answer.)

(b) Area of the triangle = ?

A.  $4.5 \text{ cm}^2$  B.  $9 \text{ cm}^2$  C.  $12 \text{ cm}^2$  D.  $18 \text{ cm}^2$  E.  $36 \text{ cm}^2$  F.  $4.5 \text{ cm}$  G.  $9 \text{ cm}$  H.  $12 \text{ cm}$  I.  $18 \text{ cm}$  J.  $36 \text{ cm}$  K.  $4.5 \text{ cm}^2$  L.  $9 \text{ cm}^2$  M.  $12 \text{ cm}^2$  N.  $18 \text{ cm}^2$  O.  $36 \text{ cm}^2$  P.  $4.5 \text{ cm}$  Q.  $9 \text{ cm}$  R.  $12 \text{ cm}$  S.  $18 \text{ cm}$  T.  $36 \text{ cm}$

(There may be more than one correct answer, but please select only ONE answer.)

Solve for  $x$ .

$\frac{3}{2} = 7x$

A.  $\frac{14}{3}$  B.  $\frac{3}{14}$  C.  $\frac{21}{2}$  D.  $\frac{21}{14}$

(There may be more than one correct answer, but please select only ONE answer.)

$v^2 = v_0^2 + 2ad$

$v_0 = 0$

$a = \frac{\Delta v}{\Delta t}$

$\Delta v = 60$

$\Delta t = 8$

$v = 30$

$d = ?$

A.  $d = 30$  B.  $d = 60$  C.  $d = 120$  D.  $d = 240$  E.  $d = 480$

(There may be more than one correct answer, but please select only ONE answer.)

$cy = dx$

$a - y = bx$

$x = ?$

A.  $\frac{ac}{d+b}$  B.  $\frac{ac}{d-b}$  C.  $\frac{ac}{bc-d}$  D.  $\frac{ac}{bc+d}$  E.  $\frac{ac}{db}$  F.  $\frac{a}{b+d}$  G.  $\frac{a}{b-d}$  H.  $\frac{1}{b} \left( \frac{a-d}{c} \right)$  I.  $\frac{1}{b} (a - \frac{d}{c})$  J.  $\frac{a}{d} (a - b)$

(There may be more than one correct answer, but please select only ONE answer.)

## Summary

- Performance on the full diagnostic is somewhat predictive of final course grades
- Performance on a three-item subset of diagnostic items may also be somewhat predictive of final course grades
- Preliminary evidence suggests that “exceptions to the rule” regarding predictability of course performance may be explainable in part by motivational factors

What is the value of  $\theta$ ? #3

A.  $\cos(3/6)$  B.  $\sin(3/6)$  C.  $\tan(3/6)$  D.  $\cos^{-1}(3/6)$  E.  $\sin^{-1}(3/6)$  F.  $\tan^{-1}(3/6)$  G.  $30^\circ$  H.  $45^\circ$  I.  $60^\circ$  J.  $27^\circ$  K.  $3/6$  L.  $0.524$

(There may be more than one correct answer, but please select only ONE answer.)

Performance on 3-item subset may approximately predict final course grade

Example: #3, #11, #12

$\frac{a/b}{c^2/d} = ?$  #11

A.  $\frac{ac^2}{bd}$  B.  $\frac{ad}{bc^2}$  C.  $\frac{bd}{ac^2}$  D.  $\frac{bc^2}{ad}$

(There may be more than one correct answer, but please select only ONE answer.)

Solve for  $x$ . #12

$\frac{3}{2} = 7x$

A.  $\frac{14}{3}$  B.  $\frac{3}{14}$  C.  $\frac{21}{2}$  D.  $\frac{21}{14}$

(There may be more than one correct answer, but please select only ONE answer.)

### Calculus-based Physics, 1<sup>st</sup> semester (UWF)

$N = 95$ , 32% with final grade B+/A-/A

0 or 1 correct on [#3, #11, #12]  
( $N = 21$ )

5% with final grade B+/A-/A

3/3 correct on [#3, #11, #12]  
( $N = 44$ )

52% with final grade B+/A-/A

### Algebra-based Physics, 1<sup>st</sup> semester (ASU Poly)

$N = 82$ , 49% with final grade B+/A-/A

0 or 1 correct on [#3, #11, #12]  
( $N = 20$ )

35% with final grade B+/A-/A

3/3 correct on [#3, #11, #12]  
( $N = 20$ )

65% with final grade B+/A-/A

### Preliminary Finding:

- Performance on full online diagnostic can approximately predict final course grade

Three samples:

Calculus-based physics, 1<sup>st</sup> semester (UWF)

Algebra-based physics, 2<sup>nd</sup> semester (ASU Tempe)

Algebra-based physics, 1<sup>st</sup> semester (ASU Polytechnic)

### Calculus-based Physics, 1<sup>st</sup> semester (UWF)

$N = 95$ , 32% with final grade B+/A-/A

<70% correct responses (full diagnostic)  
( $N = 35$ )

6% with final grade B+/A-/A

>92% correct responses (full diagnostic)  
( $N = 21$ )

62% with final grade B+/A-/A

### Algebra-based Physics, 2<sup>nd</sup> semester (ASU Tempe)

$N = 118$ , 59% with final grade A-/A+/A

<86% correct responses (full diagnostic)  
( $N = 101$ )

53% with final grade A-/A+/A

>92% correct responses (full diagnostic)  
( $N = 17$ )

94% with final grade A-/A+/A

### Algebra-based Physics, 1<sup>st</sup> semester (ASU Poly)

$N = 82$ , 34% with final grade A-/A+/A

<57% correct responses (full diagnostic)  
( $N = 29$ )

14% with final grade A-/A+/A

>81% correct responses (full diagnostic)  
( $N = 16$ )

63% with final grade A-/A+/A

