Instructor: Hacker  Name:____________________________
Course: Physics 121 (Spring 2013)
Sample Exam 2 (Mathematical Preliminaries)

Print your name neatly. If you forget to write your name, or if the grader can’t read your writing, you can lose up to 100 points. Answer all the questions that you can.

This exam will consist of 21 multiple-choice problems. You may not use calculators or other electronic devices on this exam. The use of such a device will be regarded as an attempt to cheat, and will be pursued accordingly. All diagrams and figures on this exam are rough sketches: they are not generally drawn to scale.

No partial credit will be given for these problems. However, you can miss one of the 21 problems without penalty. Your grade will be based on your best 20 problems. You will not receive extra credit for getting all 21 right.

Your grade on the exam will be based entirely on the answers that you circle on this sheet. If you have no answer or a wrong answer there, the grader will not look at the page with the problem to see if the right answer appears there. Illegible or ambiguous answers will be graded as wrong. You are responsible for copying your answers clearly, correctly, and in the right place.

Although there is no partial credit on this exam, you must show your work in the space provided on the exam. There is additional scratch paper at the end of the exam: do not use it unless you have filled all the scratch space provided on the page with the problem. If you answer a difficult problem without doing any written work, the grader will assume that you got the answer by guessing or by copying from someone else, and will not give you credit for the problem even though you’ve indicated the correct solution on the answer sheet.

Circle your answers here. Do not detach this sheet from the test.

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Measurement: Dimensions, Units, and Sig. Fig.s

Dimensional Consistency

Problem 1. Consider the formulas (i) and (ii). Are the formulas dimensionally consistent? Here $A = \text{area}$, $r = \text{distance}$, $x = \text{distance}$, $t = \text{time}$, and $v = \text{velocity}$.

(i) $A = 4\pi r^2$  
(ii) $v = \frac{x}{t}$

(a) (i) is consistent; (ii) is not  
(b) (ii) is consistent; (i) is not  
(c) Both (i) and (ii) are consistent  
(d) Neither (i) nor (ii) is consistent  
(e) None of these

Problem 2. Determine whether equations (i) and (ii) below are dimensionally consistent.

(i) $v = \frac{x - x_0}{t}$  
(ii) $x = a(t + v)^2$

where $x = \text{distance}$, $v = \text{velocity}$, $t = \text{time}$, and $a = \text{acceleration}$.

(a) (i) is dimensionally consistent; (ii) is dimensionally inconsistent  
(b) (i) is dimensionally inconsistent; (ii) is dimensionally consistent  
(c) (i) and (ii) are both dimensionally consistent  
(d) (i) and (ii) are both dimensionally inconsistent

Units

Problem 3. A German shepherd weighs 77 lb. Which is the correct conversion factor for the relationship $2.2 \text{ lb} = 1 \text{ kg}$ to convert the dog’s mass into kilograms?

(a) $\frac{2.2 \text{ lb}}{1 \text{ kg}}$  
(b) $\frac{1 \text{ kg}}{2.2 \text{ lb}}$  
(c) $2.2 \text{ kg} \cdot \text{lb}$  
(d) $\frac{2.2 \text{ kg}}{\text{lb}}$  
(e) None of these
Significant figures

**Problem 4.** How many significant figures are there in: \( m = 120.30 \text{ kg} \)?

(a) 2 (b) 3 (c) 4 (d) 5 (e) None of these

**Problem 5.** Calculate \( 120.51 + 3.2 \). Round your answer to the correct number of significant figures.

(a) 120 (b) 124 (c) 123.7 (d) 123.71 (e) None of these

Arc length

**Problem 6.** An angle measures 1.06 radians. What is its measurement in degrees?

(a) \( \frac{1.06\pi}{180} \) degrees (b) \( \frac{(1.06)(90)}{\pi} \) degrees (c) \( \frac{1.06}{2\pi} \) degrees (d) \( \frac{(1.06)(180)}{\pi} \) degrees (e) None of these

**Problem 7.** An angle measures 87°. Find its exact measurement in radians.

(a) \( \frac{87}{180\pi} \) rad (b) \( \frac{180}{87} \) rad (c) \( \frac{87\pi}{180} \) rad (d) \( \frac{87}{180} \) rad (e) None of these
Problem 8. In the figure at right, what is the measure of the angle \( \theta \)?

(a) \( \sqrt{14} \) rad  
(b) \( 5\pi/7 \) rad  
(c) \( 5/7 \) rad  
(d) \( 7/5 \) rad  
(e) None of these

Problem 9. A circle has a radius of 5 cm. A central angle has measure \( \theta = \pi/3 \) rad. What is the length of the arc intercepted by the angle?

(a) \( 2/15 \) cm  
(b) \( 5\pi/3 \) cm  
(c) \( 5/3 \) cm  
(d) \( 10\pi/3 \) cm  
(e) None of these

Problem 10. A bicycle wheel has a radius of 27 inches. It turns so that a point on the rim travels 11 inches. What angle has the wheel turned through? Round your answer to the nearest 0.01 rad.

(a) \( 27/11 \) rad  
(b) \( 11 \) rad  
(c) \( 1 \) rad  
(d) \( 11/27 \) rad  
(e) None of these

Trigonometry

Problem 11. In the figure at right, \( v/u = ? \)

(a) \( 1/\sin \alpha \)  
(b) \( \tan \alpha \)  
(c) \( 1/\tan \alpha \)  
(d) \( \sin \alpha \)  
(e) None of these

Problem 12. Use a drawing of a special triangle, or from memory, determine \( \sin 30^\circ \).

(a) \( 1/\sqrt{2} \)  
(b) \( 1/2 \)  
(c) \( \sqrt{3}/2 \)  
(d) \( 1 \)  
(e) None of these
Problem 13. A highway runs directly east and west. An airplane flies across the highway in a direction $\theta = 34^\circ$ north of east. What is the total distance that the airplane will fly before it is 21 miles north of the highway? Round your answer to the nearest tenth of a mile.

(a) $\tan 34^\circ / 21$ miles  
(b) $21 \cos 34^\circ$ miles  
(c) $\sin 34^\circ / 21$ miles  
(d) $21 / \sin 34^\circ$ miles  
(e) None of these

Problem 14. Let $\theta$ be an acute angle such that $\cos \theta = 2$, determine the value of $\theta$ in terms of the fundamental angles $30^\circ$, $45^\circ$, $60^\circ$, and $90^\circ$.

(a) $30^\circ$  
(b) $45^\circ$  
(c) $60^\circ$  
(d) $90^\circ$  
(e) No such angle

Problem 15. In the figure at right find the exact value of $\phi$. (The figure is not necessarily drawn to scale.)

(a) $\phi = \sin^{-1}(8/7)$  
(b) $\phi = \tan^{-1}(7/8)$  
(c) $\phi = \tan^{-1}(8/7)$  
(d) $\phi = \cos^{-1}(7/8)$  
(e) None of these

Problem 16. An angle with measure $\theta$ degrees is in the third quadrant. What is $\sin \theta$?

(a) $\sin(\theta - 180^\circ)$  
(b) $\sin(360^\circ - \theta)$  
(c) $-\sin(\theta - 180^\circ)$  
(d) $-\sin(\theta - 360^\circ)$  
(e) None of these
Vectors

Problem 17. Which of the vectors in the graph corresponds to \(-10\hat{i} + 5\hat{j}\)?

(a) \(\vec{A}\)  
(b) \(\vec{B}\)  
(c) \(\vec{C}\)  
(d) \(\vec{D}\)  
(e) None of these

Problem 18. The vectors \(\vec{X}\), \(\vec{Y}\), and \(\vec{Z}\) are labelled on the figure at right. Which of the following equations is true?

(a) \(\vec{Z} = \vec{X} - \vec{Y}\)  
(b) \(\vec{Z} = \vec{Y} - \vec{X}\)  
(c) \(\vec{Z} = \vec{X} + \vec{Y}\)  
(d) \(\vec{Z} = -\vec{X} - \vec{Y}\)  
(e) None of these

Problem 19. \(\vec{A} = \langle -1, 5 \rangle\) and \(\vec{B} = \langle -2, -3 \rangle\). Find \(\vec{A} + \vec{B}\).

(a) \(\langle -3, 2 \rangle\)  
(b) \(\langle 4, -5 \rangle\)  
(c) \(\langle 3, 8 \rangle\)  
(d) \(\langle 2, -15 \rangle\)  
(e) None of these
Problem 20. If $\vec{A} = \langle -3, 4 \rangle$, what is the magnitude of $\vec{A}$?

(a) 25  (b) 7  
(c) 5  (d) $\sqrt{7}$  
(e) None of these

Problem 21. An airplane is flying at a speed of 190 mph in a direction 24° north of east. What is the northward component of the plane’s velocity? Round your answer to the nearest mph.

(a) 190 sin 24° mph  (b) 190 cos 24° mph  
(c) 190 sin 66° mph  (d) 190 tan 66° mph  
(e) None of these