Midterm Exam #1, Part A

Exam time limit: 50 minutes. You may use a calculator and both sides of ONE sheet of notes, handwritten only. Closed book; no collaboration. Ignore friction and air resistance in all problems, unless told otherwise.

Part A: For each question, fill in the letter of the one best answer on your bubble answer sheet.

Physical constants: \( g = 9.80 \text{ m/s}^2 \)

(2 pts. each) Convert the following quantities into the given units:

1. \( 430 \text{ km} = \underline{\text{__________}} \text{ cm} \)
   - A. \( 4.3 \times 10^{-7} \text{ cm} \)
   - B. \( 4.3 \times 10^{-5} \text{ cm} \)
   - C. \( 4.3 \times 10^{-3} \text{ cm} \)
   - D. \( 4.3 \times 10^5 \text{ cm} \)
   - E. \( 4.3 \times 10^7 \text{ cm} \)

2. \( 3.5 \text{ mm/s} = \underline{\text{__________}} \text{ m/min} \)
   - A. \( 0.21 \text{ m/min} \)
   - B. \( 2.1 \text{ m/min} \)
   - C. \( 2.1 \times 10^2 \text{ m/min} \)
   - D. \( 2.1 \times 10^3 \text{ m/min} \)
   - E. \( 2.1 \times 10^4 \text{ m/min} \)

3. \( 7.5 \times 10^{-4} \text{ km}^2 = \underline{\text{__________}} \text{ m}^2 \)
   - A. \( 0.075 \text{ m}^2 \)
   - B. \( 7.5 \text{ m}^2 \)
   - C. \( 750 \text{ m}^2 \)
   - D. \( 7.5 \times 10^4 \text{ m}^2 \)
   - E. \( 7.5 \times 10^6 \text{ m}^2 \)

4. (1 pt.) How many **significant figures** does the value “\( 4.0050 \times 10^6 \text{ kg} \)” have?
   - A. 2
   - B. 3
   - C. 4
   - D. 5
   - E. 6

5. (2 pts.) How many **megabytes** are in one **terabyte**?
   - A. \( 10^3 \)
   - B. \( 10^6 \)
   - C. \( 10^9 \)
   - D. \( 10^{12} \)
   - E. \( 10^{15} \)
A 110-kg basketball player can jump a vertical distance of 1.3 meters (approx. 4 feet). For this entire problem, assume that the athlete has NO horizontal motion. (Ignore air resistance.)

6. (2 pts.) What must be the player’s initial vertical velocity as he leaves the ground?
   A. 3.4 m/s   D. 9.2 m/s
   B. 5.0 m/s   E. 11 m/s
   C. 7.6 m/s

7. (1 pt.) At the moment the athlete reaches his maximum height, which of the following is/are equal to zero?
   A. his velocity
   B. his speed
   C. his acceleration
   D. A & B only
   E. all of the above

8. (2 pts.) How much total time elapses during his entire jump, from take-off to landing?
   A. 0.78 s   D. 1.6 s
   B. 1.0 s   E. 1.9 s
   C. 1.3 s

9. (1 pt.) Suppose that a smaller, 75-kg athlete jumps with the same initial velocity as the 110-kg athlete does. Which one of the following is TRUE?
   A. The 75-kg athlete will reach a greater maximum height.
   B. The 75-kg athlete will reach a lower maximum height.
   C. The 75-kg athlete will be in the air for a longer period of time before landing.
   D. The 75-kg athlete will be in the air for a shorter period of time before landing.
   E. None of the above.

Six different cars move along one-dimensional tracks. The following six graphs represent their velocities as functions of time:

10. (1 pt.) Which of the above car(s) has a constant speed?
    A. (1) only   D. (2) & (6) only
    B. (2) only   E. (1), (2) & (6)
    C. (6) only

11. (1 pt.) Which of the above car(s) has a constant negative acceleration?
    A. (4) only   D. (5) & (6) only
    B. (5) only   E. (4), (5) & (6)
    C. (6) only

12. (1 pt.) Which of the above car(s) is slowing down?
    A. (4) only   D. (5) & (6) only
    B. (5) only   E. (4), (5) & (6)
    C. (6) only

13. (2 pts.) Which of the above car(s) has a displacement graph roughly like this one:
    A. (4) only   D. (5) & (6) only
    B. (5) only   E. (4), (5) & (6)
    C. (6) only
Physics 151
February 13, 2008

Score: _____________________________

Midterm Exam #1, Part B

**Part B: Show your work** on all free-response questions. Be sure to use **proper units** and **significant figures** in your final answers. For any multiple-choice questions, circle the letter of the one best answer (unless more than one answer is asked for).

1. While doing a treasure hunt with a team of your friends, you receive the instructions shown at right:

   **a.** (8 pts.) Instead of measuring out and walking along each individual segment, you convince your friends that it is faster to add together the six displacement vectors to find their sum, and then go directly to the end! Find the **magnitude** and **direction** of the **net (total) displacement** that you should travel from your starting point. **Show your work, and explain any shortcuts.**

   **Note:** You are welcome to use compass directions in your final answer, but express your final direction explicitly and clearly. **Examples:** “30.0˚ to the E of N,” or “60.0˚ to the N of E.”

   **b.** (6 pts.) Suppose that a different team doing the same treasure hunt does not know how to add vectors, so they traverse all of the separate path segments as given in the clue, eventually arriving at the treasure 15.0 minutes later. Find the magnitudes of this team’s **average speed** and **average velocity**, both in \([\text{m/s}]\). **Show your work.**
2. A cannon at the top of a cliff always fires cannonballs with an initial velocity of 60.0 m/s. Two identical cannonballs are fired at different initial angles (ignoring air resistance):
   Cannonball A is fired at 20.0° above the horizontal, and takes 7.56 s to land.
   Cannonball B is fired at 20.0° below the horizontal, and takes 3.37 s to land.

a. (6 pts.) Decompose BOTH cannonballs’ initial velocities, $v_{A0}$ and $v_{B0}$, into their $x$- and $y$-components. Finish by writing out both $v_{A0}$ and $v_{B0}$ in component notation. *Show your work clearly, and explain any shortcuts.*

b. (4 pts.) Using the information for either cannonball A or B (you don’t need both), find the height $H$ of the cliff. *Show your work.*
2. continued:

c. (6 pts.) On the axes provided, carefully and accurately graph the VERTICAL component of each cannonball’s velocity versus time, from launch to landing. (You do NOT need to show any calculations for this part. Hint: For each cannonball, find and plot the initial and final velocities, then connect them with the appropriate mathematical curve.)

cannonball A:

<table>
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<th>time [s]</th>
<th>VERTICAL component of velocity [m/s] for cannonball A</th>
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</thead>
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<tr>
<td>1</td>
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<tr>
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<tr>
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<td>0</td>
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<tr>
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<td>20</td>
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<td>40</td>
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<td>-20</td>
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<tr>
<td>8</td>
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lands at $t = 7.56$ s

cannonball B:

<table>
<thead>
<tr>
<th>time [s]</th>
<th>VERTICAL component of velocity [m/s] for cannonball B</th>
</tr>
</thead>
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lands at $t = 3.37$ s