Physics 123 - Analytical Physics I  
First Midterm Exam  
Sunday Oct. 12, 2014  
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SIGN HERE:

1. The exam will last from 6:10 - 7:30 p.m. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
2. In the section labeled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit RUID Number.
4. Enter 123 under COURSE, and your section number (see label above) under SEC.
5. Under CODE enter the exam code given above.
6. During the exam, you may use pencils, a calculator, and one 8.5 × 11 inch sheet (both sides) with handwritten formulas and notes.
7. There are 17 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. At the end of the exam, hand in the answer sheet and the cover page. Retain this question paper for future reference and study.
8. When you are asked to open the exam, make sure that your copy contains all 17 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.
10. If needed, the acceleration due to gravity on earth may be taken as \( g = 9.8 \, \text{m/s}^2 \).
1. The plot below shows the position versus time for a ball. Which of the following statements is true?
   
   a) From $t = 0$ to $t = 6 \text{ s}$, the velocity of the ball is always positive.
   
   b) The speed of the ball is the same at $t = 1 \text{ s}$, $t = 5.5 \text{ s}$, and $t = 7.5 \text{ s}$.
   
   c) The velocity of the ball is the same at $t = 1 \text{ s}$ and $t = 6 \text{ s}$.
   
   d) The acceleration of the ball is non-zero and negative at $t = 6 \text{ s}$.
   
   e) At $t = 6 \text{ s}$, the ball is at rest.

2. An object is thrown vertically into the air. Which of the following five graphs represents the velocity of the object as a function of the time?

   a)  
   
   b)  
   
   c)  
   
   d)  
   
   e)  

3. Consider what happens when you jump up in the air. Which of the following is the most accurate statement?

   a) When you jump up the earth exerts a force $F_1$ on you and you exert a force $F_2$ on the earth. You go up because $|F_1| > |F_2|$.
   
   b) When you push down on the earth with a force greater than your weight, the earth will push back with the same magnitude force and thus propel you into the air.
   
   c) Since the ground is stationary, it cannot exert the upward force necessary to propel you into the air. Instead, it is the internal forces of your muscles acting on your body itself that propels the body into the air.
   
   d) It is the upward force exerted by the ground that pushes you up, but this force can never exceed your weight.
   
   e) You are able to spring up because the earth exerts a force upward on you that is stronger than the downward force you exert on the earth.

4. A bicycle travels 308.5 m in a straight line in 40.3 s. The correct way to state the magnitude of its average velocity is:

   a) 7.66 m/s
   
   b) 7.7 m/s
   
   c) 7.6 m/s
   
   d) 7.6550868 m/s
   
   e) 7.655 m/s

5. A stone is dropped from rest from a tower at $t = 0 \text{ s}$. A second stone is dropped from rest from the same spot one second later. What is the distance between them at $t = 3 \text{ s}$ respectively? Neglect air resistance and assume $g = 10 \text{ m/s}^2$.

   a) 20 m
   
   b) 30 m
   
   c) 15 m
   
   d) 2 m
   
   e) 25 m
6. Consider the following five graphs shown (note the axes carefully).

Which of these represent(s) motion at constant speed?

a) IV and V only  
b) I, II, and III only  
c) I and IV only  
d) I and II only  
e) IV only  

7. Which of the following products of ratios gives the conversion factor to convert miles per hour \((\text{mi/h})\) to meters per second \((\text{m/s})\)? (Note that f = foot)

\[
\begin{align*}
a) \quad 5280 \text{ f} & \quad 12 \text{ in} & \quad 1 \text{ in} & \quad 1 \text{ m} & \quad 1 \text{ h} \\
b) \quad 5280 \text{ f} & \quad 12 \text{ in} & \quad 2.54 \text{ cm} & \quad 100 \text{ cm} & \quad 3600 \text{ s} \\
c) \quad 1 \text{ mi} & \quad 1 \text{ f} & \quad 1 \text{ in} & \quad 1 \text{ m} & \quad 1 \text{ h} \\
d) \quad 5280 \text{ f} & \quad 12 \text{ in} & \quad 2.54 \text{ cm} & \quad 1 \text{ m} & \quad 1 \text{ h} \\
e) \quad 5280 \text{ f} & \quad 1 \text{ in} & \quad 2.54 \text{ cm} & \quad 100 \text{ cm} & \quad 3600 \text{ s}
\end{align*}
\]

8. Of the following situations, which one is impossible?

a) A body simultaneously having constant velocity and variable acceleration  
b) A body simultaneously having velocity east and acceleration east  
c) A body simultaneously having velocity east and acceleration west  
d) A body simultaneously having zero velocity and non-zero acceleration  
e) A body simultaneously having constant acceleration and variable velocity  

9. A 2.00 m by 3.00 m plate of aluminum has a mass of 324 kg. What is the thickness of the plate? (The density of aluminum is \(2.70 \times 10^3 \text{ kg/m}^3\)).

a) 3.00 cm  
b) 2.00 cm  
c) 1.00 cm  
d) 5.00 cm  
e) 4.00 cm  

10. A helicopter takes off, going straight up 1000 m. It then goes northeast at this altitude for 30 seconds at a constant acceleration of \(2 \text{ m/s}^2\). At this point its distance from where it took off is

a) 1350 m  
b) 1900 m  
c) 900 m  
d) Need more information  
e) 1640 m  

11. Two balls, projected at different times so they don’t collide, have trajectories A and B, as shown below. Which statement is correct?

a) Ball B has a greater acceleration than ball A.  
b) Ball B’s initial speed must be greater than that of ball A.  
c) Ball B is in the air for a longer time than ball A.  
d) Ball A has a greater acceleration than ball B.  
e) Ball A is in the air for a longer time than ball B.
12. Peter is driving east in the right lane of a highway at a speed of 31 m/s. George is in the left lane and driving west at 18 m/s. What is Peter’s velocity, relative to George?
   a) 13 m/s, West
   b) 13 m/s, East
   c) 49 m/s, East
   d) 49 m/s, West
   e) 31 m/s, East

13. A 0.20-km wide river has a uniform flow speed of 3.0 m/s toward the east. A boat with a speed of 8.0 m/s relative to the water leaves the south bank and heads in such a way that it crosses to a point directly north of its departure point. How long does it take the boat to cross the river?
   a) 27 s
   b) 40 s
   c) 23 s
   d) 25 s
   e) 18 s

14. If the only forces acting on a 2.0-kg mass are \( \mathbf{F}_1 = (3\mathbf{i} - 8\mathbf{j}) \) N and \( \mathbf{F}_2 = (5\mathbf{i} + 3\mathbf{j}) \) N, what is the magnitude of the acceleration of the mass?
   a) 1.5 m/s\(^2\)
   b) 9.4 m/s\(^2\)
   c) 7.2 m/s\(^2\)
   d) 4.7 m/s\(^2\)
   e) 6.5 m/s\(^2\)

15. A projectile starts at the coordinate origin, where the displacement vector also originates. The initial velocity, \( \mathbf{v}_0 \), makes an angle \( \theta \) with the horizontal where \( 0 < \theta < 90^\circ \). At the instant when the projectile is at the highest point of its trajectory, the displacement, velocity and acceleration vectors are \( \mathbf{r}, \mathbf{v}, \text{ and } \mathbf{a} \). Which statement is true?
   a) \( \mathbf{v} \) is parallel to \( \mathbf{a} \).
   b) \( \mathbf{r} \) is perpendicular to \( \mathbf{v} \).
   c) \( \mathbf{v} \) is perpendicular to \( \mathbf{a} \).
   d) \( \mathbf{r} \) is parallel to \( \mathbf{v} \).
   e) \( \mathbf{r} \) is perpendicular to \( \mathbf{a} \).

16. A rock is thrown horizontally at 6.0 m/s off the top of a vertical cliff which is 240 m high. How far will the rock strike horizontally from the base of the cliff? (Ignore air resistance.)
   a) 290 m
   b) 42 m
   c) 84 m
   d) 49 m
   e) 7.0 m

17. The vectors \( \mathbf{a}, \mathbf{b} \), and \( \mathbf{c} \) are related by \( \mathbf{c} = \mathbf{a} + \mathbf{b} \). Which diagram illustrates this relationship?
   a) 
   b) none of these
   c) 
   d) 
   e) 

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