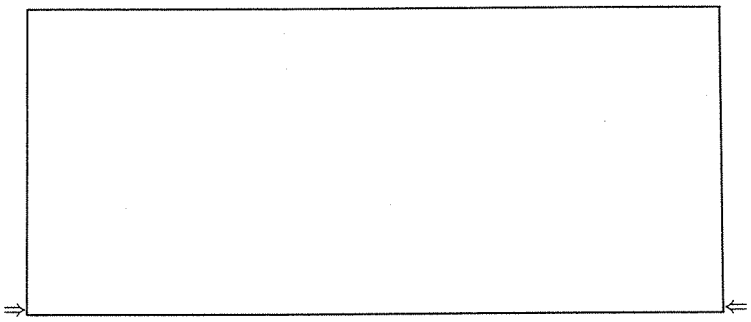
SOLUTIONS

Physics 123 - Analytical Physics – FIRST COMMON HOUR EXAM

Monday, October 8, 2007

Professor Madey and J. Lucido



Your name sticker with **exam code. SIGN HERE:**

1. The exam will last from 9:40 - 11:00 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 labelled 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 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 x 11 inch sheet (both sides) with formulas and notes.
7. There are 15 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 15 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. Some possible useful information $g = 9.80\ m/s^2$

Common Hour Exam I, Form 1

1.) A jet plane lands with $v_{ox} = 100$ m/s, and the braking acceleration is $a_x = -3.50$ m/s^2. How far does it travel before stopping?

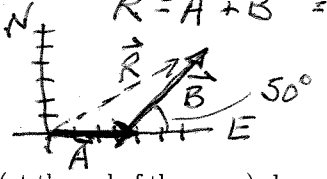
A) 135 m
B) 1400 m
C) 3800 m
D) 1200 m
E) 3500 m

$v_x^2 = v_{ox}^2 + 2a_x(x - x_0)$ ($v_x = 0$)

$x = -\frac{v_{ox}^2}{2a_x} = -\frac{(100\ m/s)^2}{-2 \times 3.50\ m/s^2} = 1430\ m$

2.) A woman walks 4.00 km east, and then 5.00 km at 50 degrees north of east. What is the magnitude of her resultant displacement?

A) 8.70 km
B) 8.17 km
C) 9.00 km
D) 8.46 km
E) 9.53 km



$\vec{R} = \vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$

$A_x = 4.00$, $A_y = 0$; $B_x = 5.00\cos 50°$; $B_y = 5.00\sin 50°$

$\vec{R} = 7.21\hat{i} + 3.83\hat{j}$

$R = \sqrt{(7.21)^2 + (3.83)^2} = 8.16\ km$

3.) The plot (at the end of the exam) shows the position versus time for a ball. Which of the following statements is true?

A) The acceleration of the ball is non-zero and negative at t=6 s.
B) At t = 6 s, the ball is at rest.
C) The speed of the ball is the same at t=1 s, t= 5.5 s, and t = 7.5 s.
D) From t=0 to t=6 s, the velocity of the ball is always positive.
E) The velocity of the ball is the same at t=1 s and t=6 s.

4.) A rock is thrown downward from an unknown height above the ground with an initial speed of 10 m/s. It strikes the ground 2.0 s later. Determine the initial height of the rock above the ground.

A) 60 m
B) 14 m
C) 40 m
D) 74 m
E) 30 m

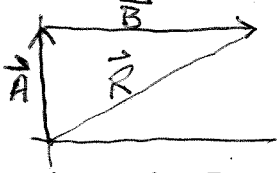
$v_{oy} = -10\ m/s$ $t = 2.0\ s$ $y_0 = 0$

$y = v_{oy}t - \frac{1}{2}gt^2$

$y = -10\ m/s \times 2.0\ s - \frac{1}{2}\left(9.8\frac{m}{s^2}\right)(4.0\ s^2) = -40\ m$

5.) A helicopter takes off, going straight up 1000 m, and then stops. After a few seconds, it begins to fly horizontally in a straight line at this altitude for 30.0 seconds at a constant acceleration of 2.00 m/s^2. At this point its displacement from where it took off is

A) 900 m
B) 1900 m
C) 1350 m
D) 1640 m
E) Need more information.



$A = 1000\ m$ $B = \frac{1}{2}a_x t^2 = \frac{1}{2}\left(2.00\frac{m}{s^2}\right)(30.0\ s)^2$

$B = 900\ m$

$R = \sqrt{(1000)^2 + (900)^2} = 1350\ m$

6.) Which answer represents the sum of 7.56E-2 and 1.2E-4 to the best number of significant digits?

A) 0.076
B) 0.08
C) 0.07572
D) 0.075720
E) 0.0757

$0.0756 + 0.00012 = 0.0757$

7.) A vector $\mathbf{A} = \hat{\mathbf{4j}} - \hat{\mathbf{5k}}$ is added to $\mathbf{B} = \hat{\mathbf{6i}} - \hat{\mathbf{8j}}$. The magnitude of the resultant vector is [Hint: Note the direction of the unit vectors!]

A) 5.1
B) 8.8
C) 7.1
D) 11
E) 16.4

$\vec{A} = 4\hat{j} + 5\hat{k}$

$\vec{B} = 6\hat{i} - 8\hat{j}$

$\vec{R} = \vec{A} + \vec{B} = 6\hat{i} - 4\hat{j} + 5\hat{k}$

$R = \sqrt{6^2 + 4^2 + 5^2} = 8.8$

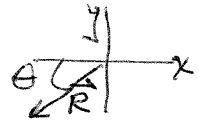
8.)Given two vectors $\mathbf{A} = -3.00\hat{\mathbf{i}}$ and $\mathbf{B} = 2.00\hat{\mathbf{j}}$, one can calculate the Resultant $\mathbf{R}$ of the vector sum $\mathbf{R} = 3\mathbf{A} - 4\mathbf{B}$. What is the angle that vector R makes with the positive x-axis? [Hint: note the quadrant!]

A) 228 deg
D) 36.9 deg
B) 48.4 deg
C) 222 deg
D) 36.9 deg
E) 41.6 deg

$3\vec{A} = -9.00\,\hat{i}$ $\quad -4\vec{B} = -8.00\,\hat{j}$

$\vec{R} = 3\vec{A} - 4\vec{B} = -9.00\,\hat{i} - 8.00\,\hat{j}$

$R = \sqrt{9.00^2 + 8.00^2} = 12.0$

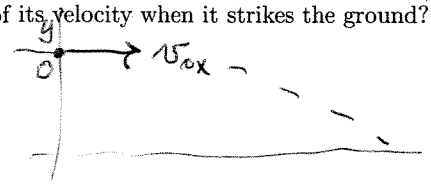


$\sin\theta = -8/12 \Rightarrow \theta = -41.8$

$\theta = 180^\circ + 42^\circ = 222^\circ$

9.) A girl serves a tennis ball horizontally at 24 m/s. If she hits the ball at an elevation of 2.5 m, what will be the magnitude of its velocity when it strikes the ground? (Ignore air resistance.)

A) 24 m/s
B) 17 m/s
C) 31 m/s
D) 25 m/s
E) 7.0 m/s



$v_y^2 = -2gy$; $v_y = \sqrt{-2\times 9.80(-2.5\,m)} = 7.0\,m/s$

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(24\,m/s)^2 + (7.0\,m/s)^2}$

$v = 25\,m/s$

10.) A car travels directly east at 50 km/hr for 100 km and then 80 km/hr for 120 km. How long does it take for the complete trip?

A) 4.0 hours
B) 3.5 hours
C) 2.0 hours
D) 1.5 hours
E) 3.0 hours

$T_1 = \frac{100\,km}{50\,km/h} = 2h$ $\quad T_2 = \frac{120\,km}{80\,km/h} = 1.5h$

$T = T_1 + T_2 = 3.5h$

11.) When you throw a ball straight up in the air, between the time it leaves your hand and the moment it hits the ground,

A) it is always moving.
B) it moves equal distance in equal time.
C) it is always accelerating.
D) it is always slowing down
E) its displacement is equal to the distance travelled.

$a_y = -g$

12.) A football is thrown upward at an angle of 30° with respect to the horizontal. In order for the throw to go 40 m, what must the initial speed of the ball be?

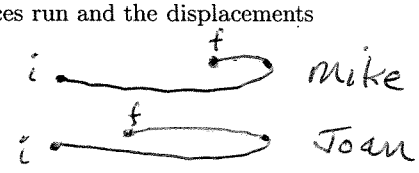
A) 10 m/s
B) 21 m/s
C) 450 m/s
D) 18 m/s
E) 28 m/s

$R = \frac{v_0^2 \sin 2\alpha}{g}$ $\quad v_0^2 = \frac{gR}{\sin 2\alpha} = \frac{9.80\,\frac{m}{s^2} \times 40m}{\sin 60^\circ}$

$v_0 = 21\,m/s$

13.) Two children start at one end of a street, the origin, run to the other end, then head back. At a specific time t on the way back Joan is ahead of Mike. Which statement is correct about the distances run and the displacements from the origin at time t?

A) Joan has run a greater distance and her displacement is greater than Mike's.
B) Joan has run a greater distance, but her displacement is less than Mike's.
C) Mike has run a greater distance, but his displacement is less than Joan's.
D) Mike has run a shorter distance, and his displacement is less than Joan's.
E) Mike has run a greater distance and his displacement is greater than Joan's.



14.) A commercial jet plane such as the Boeing 747 can cruise at a speed of 575 miles/hour. Express this speed in m/s given that 1.00 ft = 0.305 m and there are 5280 ft in a mile.

A) 257 m/s
B) 392 m/s
C) 30.6 m/s
D) 2800 m/s
E) 172 m/s

$\frac{575\,mi}{h} = \frac{575\,mi}{h} \times \frac{5280\,ft}{mi} \times \frac{0.305\,m}{ft} \times \frac{1h}{3600s}$

$= 257\,m/s$

15.) An airplane flies east from the airport to a mountain in a headwind for 3 hours. After reaching the mountain, the plane turns around heads back to the airport. The airplane flies at a constant velocity of 325 km/hr relative to the wind for the entire trip. While the plane is travelling east, it is flying against a headwind with a velocity of 30.0 km/hr relative to the ground. As it turns around, the wind blows in the same direction, but now with a speed of 50.0 km/hr relative to the ground. How long does the entire trip take?

A) 5.1 hours
B) 6.0 hours
C) 5.4 hours
D) 6.9 hours
E) 6.2 hours

E = earth
W = wind
P = plane

$\vec{v}_{P/E} = \vec{v}_{P/W} + \vec{v}_{W/E}$

Trip out: $v_{P/E} = 325\frac{km}{h} - 30\frac{km}{h} = 295\,km/h$

Time = 3h; distance = $\frac{295km}{h} \times 3h = 885km$

Return trip

$v_{P/E} = 325\frac{km}{h} + 50\frac{km}{h} = 375\,km/h$

Time = $\frac{885km}{375km/h} = 2.4\,h$

Total time = (3.0 + 2.4) h = 5.4 h

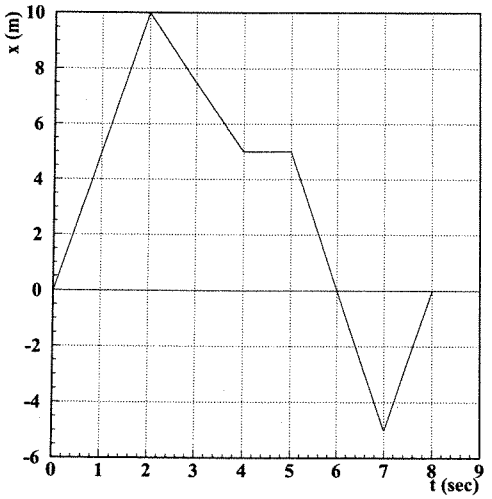


Fig. 1: Problem 3