Name:________________ ID:_______________ Lab (day/time)___________

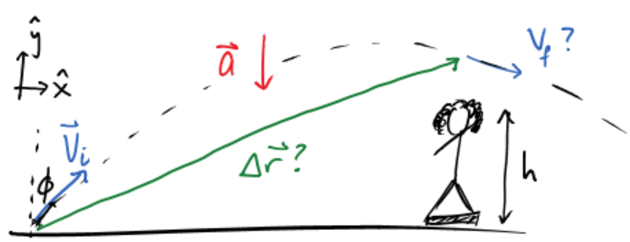
Physics 201

Midterm Exam 1

6/30/2015

Collaboration is not allowed. Allowed on your desk are: up to ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating/graphing scientific calculator, 1 page of scratch paper, writing utensils, and the exam. You will have 50 minutes to complete this exam.

1. (10 points) A water bottle rocket is launched from the ground with an initial speed of 75.0 m/s at an angle of 30.0° with respect to the vertical. The rocket is attempting to hit the head of a 11.0-m-high statue of Sir Isaac Newton (he would approve), that is a horizontal distance of 27.0 m away. Does the rocket hit the top of the statue and if not, by how much does it miss?



k

x: $a_x = 0$, $V_{ix} = |\vec{V}_i|\sin\phi = 37.5\,m/s$, $\Delta x = 27\,m$

y: $a_y = -9.8\,m/s^2$, $V_{iy} = |\vec{V}_i|\cos\phi = 64.95\,m/s$

uk

x: V_{fx}, Δt

y: V_{fy}, Δt, Δy ?

eq's

(i) $\Delta x = V_i \Delta t + \frac{1}{2} a \Delta t^2$

(ii) $V_f = V_i + a\Delta t$

(iii) $V_f^2 = V_i^2 + 2a\Delta x$

[X] (i) $\Delta x = V_{ix}\Delta t + \frac{1}{2} a_x \Delta t^2$ ($a_x \to 0$)

$\Delta t = \frac{\Delta x}{V_{ix}} = 0.72\,s$

[Y] (i) $\Delta y = V_{iy}\Delta t + \frac{1}{2} a_y \Delta t^2 \Rightarrow \Delta y = 44.23\,m$, so it misses by

$\Delta y - h = 33.2\,m$

For questions 2 through 4 circle all correct answers, a given problem may have more than one correct answer. Each correctly circled answer will receive two points. There are **4** correct answers in this section and only the first **4** circled answers will be graded. There is no partial credit.

2. Vector **A** points in the positive x-direction while vector **B** points in the negative x-direction. Which of the following statements are necessarily true regarding these vectors.

[F] (a) Vector **A** has a positive magnitude while vector **B** has a negative magnitude.
[T] (b) You can multiply vector **A** by a scalar with the proper dimensions and get vector **B**.
[?] (c) Vector **A** and vector **B** have the same dimensions.
[?] (d) Vector **A** and vector **B** have the same magnitude.
[T] (e) If Vector **A** is rotated by 180º, it will point in the same direction as vector **B**.

3. Assuming equal rates of acceleration in both cases, how much further would you travel if braking from 56 mi/h to rest than from 28 mi/h?

[F] (a) 2 times farther
[T] (b) 4 times farther
[F] (c) 3.2 times farther
[F] (d) 4.8 times farther
[F] (e) 5.2 times farther

4. A certain physical quantity, **R**, is calculated using the formula $R = 4a(b^2 - bc)$ where a, b, and c are distances. Which of the following statements are true?

[F] (a) **R** must be an acceleration.
[F] (b) **R** must be an area.
[T] (c) **R** must be a volume.
[F] (d) **R** must be a speed.
[F] (e) **R** must be a distance.

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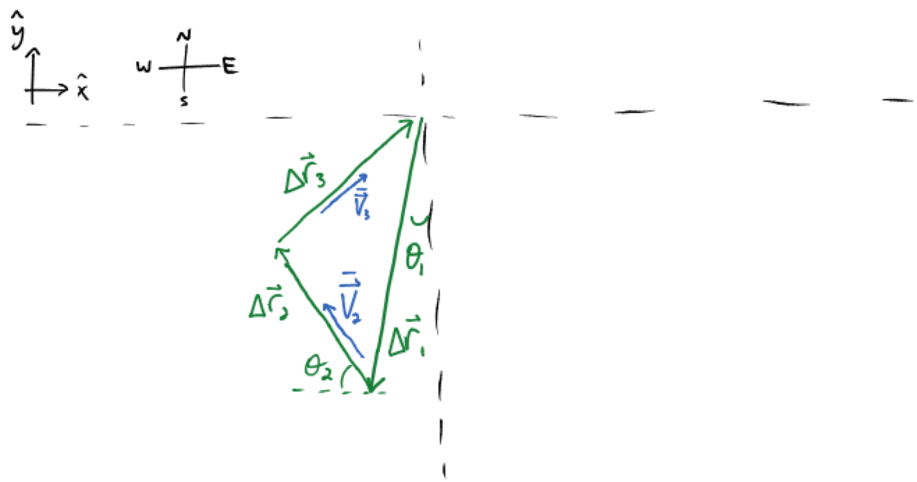
5. (4 points) If you needed to estimate the number of gallons of gasoline burned in the United States each year by automobiles, what quantities would you need to assume? What formula would you need to use (you need to create the formula)?

N = total number of cars
M = average number of miles driven each year per car
R = average number of miles per gallon

Then

$$\text{Total number of gallons} = \frac{N \cdot M}{R}$$

6. (10 points) In a physics summer camp game, contestants are told to walk 14.0 paces in a direction 15.0º from south, towards west. Then they must walk at a steady rate of 10 paces per minute in a direction 60.0º from west, towards north, for 50 seconds. What would be the final average velocity required to end up at the starting position, if they are to take exactly 2 min in their final displacement? Answer in units of paces per minute.



$$\sum \Delta \vec{r}_i = 0$$

$$\Delta \vec{r}_1 + \Delta \vec{r}_2 + \Delta \vec{r}_3 = 0$$

$$\Delta \vec{r}_1 + \vec{V}_2 \Delta t_2 + \vec{V}_3 \Delta t_3 = 0$$

$$\vec{V}_3 = \frac{1}{\Delta t_3}\left[-\Delta \vec{r}_1 - \vec{V}_2 \Delta t_2\right]$$

$\frac{50}{60}$ min

$$\vec{V}_3 = \left[-\langle -|\Delta \vec{r}_1| \sin\theta_1, -|\Delta \vec{r}_1| \cos\theta_1 \rangle - \langle -|\vec{V}_2| \cos\theta_2, +|\vec{V}_2| \sin\theta_2 \rangle \Delta t_2\right] \frac{1}{\Delta t_3}$$

$$= \frac{1}{2\,\text{min}}\left[\langle 3.623, 13.52 \rangle \text{paces} + \langle 5, -8.66 \rangle \frac{\text{paces}}{\text{min}} \left(\frac{50}{60}\,\text{min}\right)\right]$$

$$= \frac{1}{2\,\text{min}}\left[\langle 7.79, 6.303 \rangle \text{paces}\right] \Rightarrow \boxed{\vec{V}_3 = \langle 3.89, 3.15 \rangle \frac{\text{paces}}{\text{min}}}$$

Scores:

Problems

1	2-4	5	6

Exam Total