

Your Name: _____

PHY203
Final Exam #1
Chapters 1-3
Mon, 5/9/11

Part 1

Solutions

1. An ant crawls north along a wall for 3.0 meters, then turns around and crawls 2.0 meters south back towards the starting point. Find the total distance and the total displacement. (Take north as the positive x direction.)

	<u>Distance</u>	<u>Displacement</u>	
a.	1.0 m	+1.0 m	distance = 3.0 m + 2.0 m
b.	1.0 m	-1.0 m	displacement = +3.0 m - 2.0 m
c.	3.0 m	+2.0 m	
d.	5.0 m	+1.0 m	
e.	5.0 m	- 1.0 m	

2. A physics student rides her bike for 30 min covering a distance of 10 km, then returns by a different route back to the starting point, covering an additional 15 km in an additional 30 min. What was her average velocity?

- a. **0 km/hr** same start and end point: avg. vel. = 0
 b. 10 km/hr
 c. 20 km/hr
 d. 25 km/hr
 e. 50 km/hr

3. At $t = 0$, the speed of an object starting at $x=0$ and $y = -10\text{m}$ is 40 m/s. At $t=5$ sec., the particle is at $x= -15\text{m}$ and $y= 20\text{m}$ with a speed of 35 m/s.

Find the average velocity over the time interval:

- a. 22.9 m/s
 b. 37.5 m/s
 c. $3 \text{ m/s } \mathbf{i} - 6 \text{ m/s } \mathbf{j}$
 d. $-3 \text{ m/s } \mathbf{i} + 2 \text{ m/s } \mathbf{j}$ $\mathbf{v}_{\text{avg}} = (\mathbf{x}_2 - \mathbf{x}_1) / \Delta t = ((-15 \text{ m } \mathbf{i} + 20 \text{ m } \mathbf{j}) - (0 - 10 \text{ m } \mathbf{j})) / 5\text{s}$
 e. **$-3 \text{ m/s } \mathbf{i} + 6 \text{ m/s } \mathbf{j}$** $(-15 \text{ m } \mathbf{i} + 30 \text{ m } \mathbf{j}) / 5\text{s} = -3 \text{ m/s } \mathbf{i} + 6 \text{ m/s } \mathbf{j}$

4. A lead ball is dropped off a cliff on Planet XXX where the acceleration due to gravity is exactly 10 m/s^2 . 2 seconds later an identical lead ball is thrown straight down from the same cliff with an initial speed of 30 m/s. Find the time measured from when the first ball was released at which the balls are exactly side-by-side:

- a. 3.0 s $y_1 = 1/2gt^2 ; y_2 = 30(t-2) + 1/2g(t-2)^2$
 b. **4.0 s** $y_1 = y_2 : 1/2gt^2 = 30(t-2) + 1/2g(t-2)^2$
 c. 5.0 s $t = 4.0 \text{ s}$
 d. 6.0 s
 e. None of the above

For problems 5-8, consider a rocket being launched from rest straight up into the atmosphere of Planet XXX where the acceleration due to gravity is exactly 10 m/s^2 . In the first stage, the rocket accelerates at 20 m/s^2 for 15 s. Then the motor cuts off and the rocket continues to travel upwards for a while.

5. Find the height of the rocket when the motor cuts off.

- a. 75 m
 b. 150 m
 c. 1125 m
d. 2250 m
 e. 4500 m
- $$H_1 = 1/2(20 \text{ m/s}^2)(15 \text{ s})^2 = 2250\text{m}$$

6. Find the speed of the rocket when the motor cuts off.

- a. 150 m/s
b. 300 m/s
 c. 2250 m/s
 d. 4500 m/s
 e. None of the above
- $$v = (20 \text{ m/s}^2)(15 \text{ s}) = 300\text{m/s}$$

7. Find the height of the rocket at which it stops traveling upwards and begins to descend.

- a. 1125 m
 b. 2250 m
 c. 3375 m
 d. 4500 m
e. 6750 m
- $$0 = (300 \text{ m/s})^2 + 2(-10 \text{ m/s}^2)(DH)$$
- $$DH = 4500\text{m}$$
- $$H_2 = 2250\text{m} + 4500 \text{ m} = 6750 \text{ m}$$

8. Find the total time the rocket is in the air before it hits the ground.

- a. 8.8 s
 b. 23.8 s
 c. 66.2 s
d. 81.7 s
 e. 148.5 s
- $$0 = 2250 + 300 t_2 + 1/2(-10 \text{ m/s}^2) t_2^2$$
- $$t_2 = 66.7\text{s}$$
- $$t = 15\text{s} + 66.7\text{s} = 81.7\text{s}$$

9. Consider two trains running in the same direction on parallel tracks. Train 1 leaves the station at time, $t = 0$, with a constant speed of 100 m/s. Train 2 leaves the station 10 seconds later than train 1 at an initial speed of 0 m/s

but an acceleration of 20 m/s^2 . Find the time, t , at which the trains are exactly side-by-side:

- a. 3.8 s
 b. 13.1 s
 c. 16.2 s
d. 26.2 s
 e. 33.0 s
- $$x_1 = 100t ; x_2 = 1/2(20)(t-10)^2$$
- $$x_1 = x_2 : 100t = 10(t-10)^2$$
- $$100t = 10(t^2 - 20t + 100); t = 26.2 \text{ sec.}$$

10. Let $\mathbf{A} = 5\mathbf{i} - 6\mathbf{j}$, $\mathbf{B} = -10\mathbf{i} + 7\mathbf{j}$, $\mathbf{C} = 2\mathbf{A} - 3\mathbf{B}$

Write the vector, \mathbf{C} , in vector notation:

- a. **$40\mathbf{i} - 33\mathbf{j}$**
 b. $40\mathbf{i} - 9\mathbf{j}$
 c. $-20\mathbf{i} + 9\mathbf{j}$
 d. $-20\mathbf{i} - 33\mathbf{j}$
 e. None of the above
- $$\mathbf{C} = 2(5\mathbf{i} - 6\mathbf{j}) - 3(-10\mathbf{i} + 7\mathbf{j}) = 40\mathbf{i} - 33\mathbf{j}$$

11. A hockey player launches a slap shot at the net from 15 m away at an angle with the horizontal of 15° and with an initial speed of 30 m/s. The height of the net is 1.22 m. **Show your work.** (Note: use $g = 9.81 \text{ m/s}^2$).

a. Calculate the initial x and y components of the hockey puck's initial velocity *and* write the initial velocity, \mathbf{v}_i , of the puck in vector form.

$$\mathbf{v_0} = 30 \text{ m/s}(\cos 15^\circ \mathbf{i} + \sin 15^\circ \mathbf{j}) = 29 \text{ m/s } \mathbf{i} + 7.8 \text{ m/s } \mathbf{j}$$

- b. Calculate the time in sec. that it will take for the puck to reach the net.

$$15 \text{ m} = 0 + 29 \text{ m/s } t$$

$$t = 15/29 = 0.52 \text{ s}$$

- c. Determine whether the puck will enter the net or not-explain briefly why or why not.

$$\text{at the net, } y = 0 + 7.8 \text{ m/s}(0.52 \text{ s}) + 1/2(-9.81 \text{ m/s}^2)(0.52 \text{ s})^2$$

$$y = 2.73 \text{ m}$$

too high-puck goes over the top of the net

- d. If the net *were not in place*, calculate the highest point the puck would reach.

$$0 = (7.8 \text{ m/s})^2 - 2(9.81 \text{ m/s}^2) H$$

$$H = 3.1 \text{ m}$$

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