

Your Name: _____

PHY203

Exam #1

Chapters 1-3

Thurs., 9/25/08

Solutions

1. Convert 350 liters to m^3 :

- a. 0.035 m^3
b. 0.35 m^3 $350\text{l}/(1000\text{l}/\text{m}^3) = 0.35 \text{ m}^3$
 c. 3.5 m^3
 d. $3.5 \times 10^5 \text{ m}^3$
 e. None of the above

2. Convert 60 km/hr^2 to m/s^2 :

- a. $4.6 \times 10^{-3} \text{ m/s}^2$** $60 \text{ km/hr}^2 \times 1000 \text{ m/km} / (3600 \text{ s/hr})^2 = 4.6 \times 10^{-3} \text{ m/s}^2$
 b. 1.67 m/s^2
 c. 16.7 m/s^2
 d. $7.8 \times 10^5 \text{ m/s}^2$
 e. None of the above

3. Add 5.5 terameters to 250 gigameters:

- a. $5.5025 \times 10^{12} \text{ m}$
 b. $5.525 \times 10^{12} \text{ m}$
c. $5.75 \times 10^{12} \text{ m}$ $5.5 \times 10^{12} \text{ m} + .25 \times 10^{12} \text{ m} = 5.75 \times 10^{12} \text{ m}$
 d. $8.0 \times 10^{12} \text{ m}$
 e. None of the above

4. A bike rider starts from rest with an acceleration of 0.035 m/s^2 . Find how long it takes the bike rider to ride 2.0 km:

- a. 4.0 min. $2000\text{m} = 1/2(0.035)(t)^2$
 b. 11.3 min. $t = 338\text{s}/(60\text{s}/\text{min})=5.6 \text{ min}$
 c. 952 min.
 d. 1905 min.
e. None of the above

5. Consider two cars approaching an intersection from different directions. One car, traveling East, starts from rest a distance, d , from the intersection with an acceleration of 3.0 m/s^2 . The other car, traveling North at a constant speed of 15 m/s , is at the same distance, d , from the intersection when the first car starts. Assuming the cars arrive at the intersection at the same time (and crash), find the time of the crash (with $t=0$ the time the first car starts moving):

- a. 5.0s $x_1 = 1/2(3)(t)^2$; $x_2 = 15t$
 b. 7.5s $x_1 = x_2$; $15t = 0.5(3)(t)^2$
c. 10.0s $30 = 3t$; $t=10\text{s}$
 d. 20.0s
 e. None of the above

6. Consider balls being dropped or thrown off a cliff on Planet 203X whose gravity is such that $g = 10 \text{ m/s}^2$ exactly:

A lead ball is dropped off a cliff. 1.5 seconds later an identical lead ball is thrown straight down from the same cliff with an initial speed of 20 m/s. If the two balls hit the ground at the base of the cliff at the same time, find the height of the cliff

- a. 2.8m $x_1 = 1/2(10)(t)^2$; $x_2 = 20(t-1.5) + 1/2(10)(t-1.5)^2$
 b. **70.3m** $x_1 = x_2$; $1/2(10)(t)^2 = 20(t-1.5) + 1/2(10)(t-1.5)^2$
 c. 138m $5(t)^2 = 20(t-1.5) + 5(t-1.5)^2$; $(t)^2 = 4(t-1.5) + (t-1.5)^2 - 3t + 2.25$
 d. 340m $0 = 4t - 6 - 3t + 2.25$; $t = 3.75\text{s}$; $H = 70.3\text{m}$
 e. None of the above

Given the choices above, answer the following questions, 7-10:

7. Given a plot of x vs. t as shown below, which of the graphs above depicts a plot of v vs. t : a., b., c., d., or e. none of the above? **Slope is neg. and hor.**

8. Given the same plot of x vs. t as shown in #7, which of the graphs above depicts a plot of a vs. t : a., b., c., d., or e. none of the above? **Should be hor. line at 0.**

9. Given a plot of velocity vs. t as shown below, which of the graphs above depicts a plot of acceleration vs. t : a., b., c., d., or e. none of the above? **Slope is pos. and hor.**

10. Given a plot of a vs. t as shown below, which of the graphs above depicts a plot of v vs. t : a., b., c., d., or e. none of the above? **Plot must have a neg. slope.**



11. Let $\mathbf{A} = 8\mathbf{i} + 2\mathbf{j}$, $\mathbf{B} = 2\mathbf{i} - 3\mathbf{j}$, $\mathbf{C} = -4\mathbf{i} - 5\mathbf{j}$

a. Sketch and clearly label the vectors \mathbf{A} , \mathbf{B} , and \mathbf{C} on the above graph.

b. For the vector \mathbf{A} , find the magnitude of the vector and the angle the vector makes with respect to the x-axis (measured from the positive x-axis in a counterclockwise direction).

$$A = (8^2 + 2^2)^{1/2} = 8.2$$

$$\theta = \tan^{-1}(2/8) = 14^\circ$$

c. For the vector \mathbf{C} , find the magnitude of the vector and the angle the vector makes with respect to the x-axis (measured from the positive x-axis in a counterclockwise direction).

$$C = (4^2 + 5^2)^{1/2} = 6.4$$

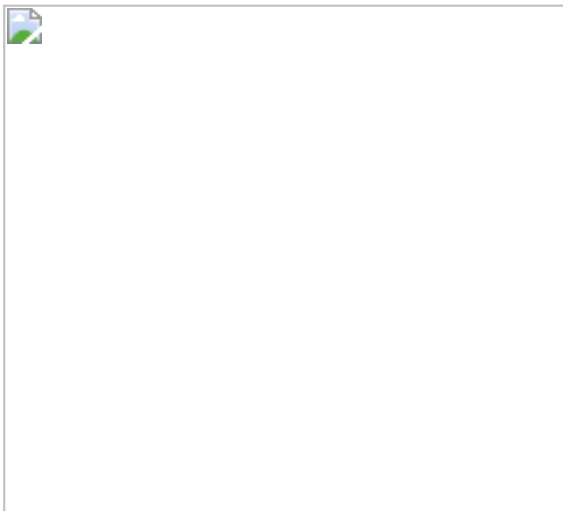
$$\theta = \tan^{-1}(5/4) = 51.3^\circ$$

$$51.3^\circ + 180^\circ = 231.3^\circ$$

d. Write the vector, $\mathbf{D} = 2\mathbf{A} - 3\mathbf{B} + 4\mathbf{C}$, in vector notation.

$$\mathbf{D} = 2(8\mathbf{i} + 2\mathbf{j}) - 3(2\mathbf{i} - 3\mathbf{j}) + 4(-4\mathbf{i} - 5\mathbf{j}) = -6\mathbf{i} - 7\mathbf{j}$$

e. Sketch and clearly label the vector \mathbf{D} on the above graph.



11. Let $\mathbf{A} = 6\mathbf{i} + 9\mathbf{j}$, $\mathbf{B} = -2\mathbf{i} + 3\mathbf{j}$, $\mathbf{C} = -3\mathbf{i} - 4\mathbf{j}$

- a. Sketch and clearly label the vectors \mathbf{A} , \mathbf{B} , and \mathbf{C} on the above graph.
- b. For the vector \mathbf{A} , find the magnitude of the vector and the angle the vector makes with respect to the x-axis (measured from the positive x-axis in a counterclockwise direction).

$$A = (6^2 + 9^2)^{1/2} = 10.8$$

$$q = \tan^{-1}(9/6) = 56.3^\circ$$

- c. For the vector \mathbf{C} , find the magnitude of the vector and the angle the vector makes with respect to the x-axis (measured from the positive x-axis in a counterclockwise direction).

$$C = (3^2 + 4^2)^{1/2} = 5.0$$

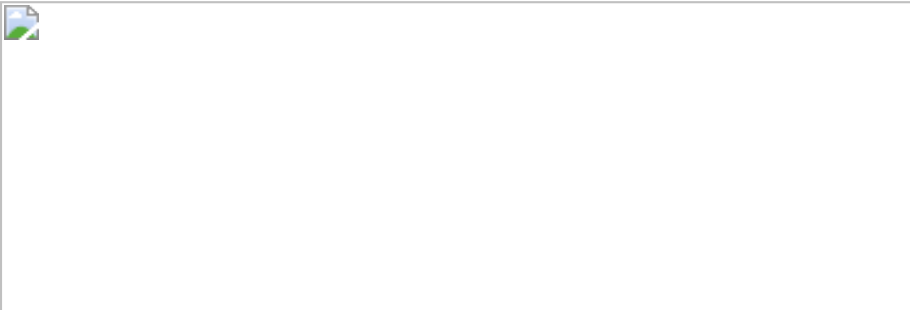
$$q = \tan^{-1}(4/3) = 53.1^\circ$$

$$51.3^\circ + 180^\circ = 233.1^\circ$$

- d. Write the vector, $\mathbf{D} = 2\mathbf{A} - 3\mathbf{B} + 4\mathbf{C}$, in vector notation.

$$\mathbf{D} = 2(6\mathbf{i} + 9\mathbf{j}) - 3(-2\mathbf{i} + 3\mathbf{j}) + 4(-3\mathbf{i} - 4\mathbf{j}) = 6\mathbf{i} - 7\mathbf{j}$$

- e. Sketch and clearly label the vector \mathbf{D} on the above graph.



12. A missile is shot in a horizontal direction from a cliff at a height of $H=500\text{m}$ at a fortress (not shown). The missile *just clears* the 200m high fortress wall at a distance of 1000m , as shown above, and eventually hits the ground at some distance past the wall. **Show your work.** (Note: use $g = 9.81 \text{ m/s}^2$)

- a. Using the coordinate system above for the y-direction, calculate the time it takes for the missile to reach the wall.

$$200 = 500 - \frac{1}{2}(9.81 \text{ m/s}^2)t^2$$

$$300 = 4.905 \text{ m/s}^2 t^2$$

$$t = 7.82 \text{ s}$$

- b. Calculate the initial speed of the missile.

$$1000\text{m} = (v_0) (7.82 \text{ s})$$

$$v_0 = 128 \text{ m/s}$$

c. Write the initial velocity vector, \mathbf{v}_0 , in vector notation (using the coordinate system above).

$$\mathbf{v}_0 = 128 \text{ m/s } \mathbf{i}$$

d. Calculate how far *past the wall* (in the x-direction) the missile will hit the ground.

$$\text{time first: } 0 = 500 - 1/2(9.81 \text{ m/s}^2)t^2$$

$$500 = 4.905 \text{ m/s } t^2$$

$$t = 10.1 \text{ s}$$

$$R = (128 \text{ m/s})(10.1 \text{ s}) = 1292\text{m}$$

$$1292\text{m} - 1000\text{m} = 292\text{m}$$

e. Calculate *and* write the final velocity, \mathbf{v}_f , of the projectile just before it hits the ground in vector form (using the coordinate system above).

$$v_{fy} = 0 - gt = -(9.81 \text{ m/s}^2)(10.1) \text{ s} = -99 \text{ m/s}$$

$$\mathbf{v}_f = 128 \text{ m/s } \mathbf{i} - 99 \text{ m/s } \mathbf{j}$$



12. A missile is shot in a horizontal direction from a cliff at a height of $H=750\text{m}$ at a fortress (not shown). The missile *just clears* the 200m high fortress wall at a distance of 1000m , as shown above, and eventually hits the ground at some distance past the wall. **Show your work.** (Note: use $g = 9.81 \text{ m/s}^2$)

a. Using the coordinate system above for the y-direction, calculate the time it takes for the missile to reach the wall.

$$200 = 750 - 1/2(9.81 \text{ m/s}^2)t^2$$

$$550 = 4.905 \text{ m/s } t^2$$

$$t = 10.6 \text{ s}$$

b. Calculate the initial speed of the missile.

$$1000\text{m} = (v_0)(10.6 \text{ s})$$

$$v_0 = 94.4 \text{ m/s}$$

c. Write the initial velocity vector, \mathbf{v}_0 , in vector notation (using the coordinate system above).

$$\mathbf{v}_0 = 94.4 \text{ m/s } \mathbf{i}$$

d. Calculate how far *past the wall* (in the x-direction) the missile will hit the ground.

$$\text{time first: } 0 = 750 - \frac{1}{2}(9.81 \text{ m/s}^2)t^2$$

$$750 = 4.905 \text{ m/s } t^2$$

$$t = 12.4 \text{ s}$$

$$R = (94.4 \text{ m/s})(12.4 \text{ s}) = 1167\text{m}$$

$$1167\text{m} - 1000\text{m} = 167\text{m}$$

e. Calculate *and* write the final velocity, \mathbf{v}_f , of the projectile just before it hits the ground in vector form (using the coordinate system above).

$$v_{fy} = 0 - gt = -(9.81 \text{ m/s}^2)(12.4) \text{ s} = -121.6 \text{ m/s}$$

$$\mathbf{v}_f = 94.4 \text{ m/s } \mathbf{i} - 121.6 \text{ m/s } \mathbf{j}$$