PH 220 Homework Assignment Chapter on Two-Dimensional Motion – 20 Problems Total

1. While trying to find a library in a strange city, Paul starts at his hotel and drives North 32.0 blocks. He then turns West and Drives 22.0 blocks. Finally turning South, he drives another 12.0 blocks arriving at the library. What is the displacement from the hotel to the library?

Solution for Problem 1

2. A speedboat is traveling on Lake Superior with a constant velocity given by:

$$150. \, ^{km}/_h \, @ \, 38.9° \, (\widehat{East}) \, of \, (\widehat{North})$$

(a) Find the components of the velocity in both the $(\widehat{East})$ and $(\widehat{North})$ directions.

(b) What is the displacement of this boat in both the $(\widehat{East})$ and $(\widehat{North})$ directions if the boat travels for a period of 3.75 h ?

Solution for Problem 2

3. Let:

$$\vec{v_1} = -8.5 \, ^m/_s \, (\widehat{i}) + 5.3 \, ^m/_s \, (\widehat{j})$$

and

$$\vec{v_2} = 3.3 \, ^m/_s \, (\widehat{i}) - 7.2 \, ^m/_s \, (\widehat{j})$$

Determine the magnitude and direction of:

(a) $\vec{v_1}$

(b) $\vec{v_2}$

(c) $\vec{v_2} + \vec{v_1}$

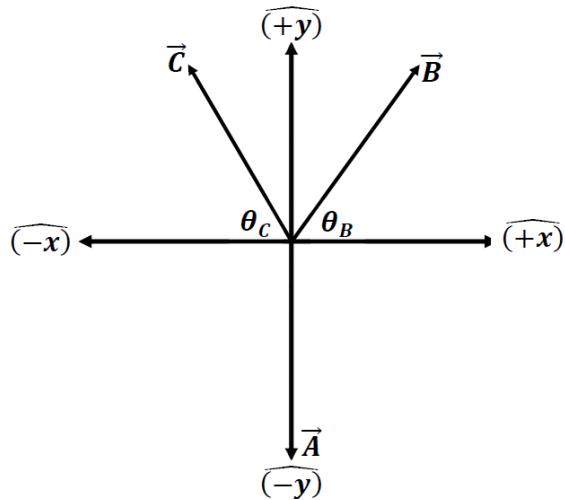**(d)** $\vec{v_2} - \vec{v_1}$

Solution for Problem 3

4. Below is a vector diagram displaying three vectors:

$$\vec{A} = 43.0 \text{ N } \widehat{(-y)}$$

$$\vec{B} = 39.0 \text{ N @ } 47.0° \text{ above } \widehat{(+x)}$$

$$\vec{C} = 37.0 \text{ N @ } 56.0° \text{ above } \widehat{(-x)}$$

Find the resultant vectors:

(a) $\vec{D} = 2\vec{C} - \vec{A}$

(b) $\vec{E} = \vec{A} + 3\vec{B} - 2\vec{C}$

Solution for Problem 4

5. The highest city in the world is La Rinconada which is found in Peru at an altitude of 5.022 km above sea level. Another city in Peru is Pucallpa which is located 890. km from La Rinconada along a line that is at an angle of 51.3° $\widehat{(\text{North})}$ of $\widehat{(\text{West})}$. Pucallpa is at an altitude of 0.155 km above sea level.

(a)   What are the components of the displacement vector going from La Rinconada to Pucallpa? Use the x- direction to be Geographic East, the y- direction as Geographic North, and the z direction as Upward.

(b)   What is the magnitude of the displacement vector?

Solution for Problem 5

6. Vector $|\vec{A}| = 113.0 \text{ }^m/_s$ and is known to be in the y-z plane. $A_z = 84.00 \text{ }^m/_s \widehat{(-k)}$.

(a)   What are the two possible y components?

(b)   Consider the y- component to be negative, determine the vector $\vec{B}$ such that $\vec{A} - \vec{B} = +200.0 \text{ }^m/_s \widehat{(j)}$.

Solution for Problem 6

7. The location of a particle is described by a time function as:

$$\vec{S} = \left((12.3 \text{ }^{m}/_{s}) \text{ t}\widehat{(i)} - (14.6 \text{ m})\widehat{(j)} + \left(2.41 \text{ }^{m}/_{s^2} \right) t^2 \widehat{(k)} \right)$$

Determine:

(a)   The particle's velocity as a function of time.

(b)   The particle's acceleration as a function of time.

Solution for Problem 7

8. An object is located at the origin when set time to Zero. In other words:

$$\overrightarrow{S_0} = (0.00 \text{ m})\widehat{(i)} + (0.00 \text{ m})\widehat{(j)} + (0.00 \text{ m})\widehat{(k)}$$

When t = 0.00 s

The object has a constant velocity at this time described by:

$$\overrightarrow{v_0} = (8.69 \text{ }^{m}/_{s}) \widehat{(k)}$$

At this time an acceleration acts on the object given by:

$$\vec{a} = \left(2.45 \text{ }^{m}/_{s^2} \right) \widehat{(i)} + \left(4.92 \text{ }^{m}/_{s^2} \right) \widehat{(j)} + \left(-1.05 \text{ }^{m}/_{s^2} \right) \widehat{(k)}$$

At the point when the object has reached its greatest height (z-direction), determine:

(a)   The velocity of the object.

(b)   The location of the object.

Solution for Problem 8

9. At time t = 0.00 s, a particle has the following initial conditions:

$$\vec{r_0} = 0.00 \text{ m}(\widehat{i}) + 0.00 \text{ m}(\widehat{j}) + 0.00 \text{ m}(\widehat{k})$$

$$\vec{v_0} = -10.0 \text{ }^m/_s (\widehat{i}) + 20.0 \text{ }^m/_s (\widehat{j}) - 15.0 \text{ }^m/_s (\widehat{k})$$

$$\vec{a} = 3.00 \text{ }^m/_{s^2} (\widehat{i}) - 6.00 \text{ }^m/_{s^2} (\widehat{j}) + 4.50 \text{ }^m/_{s^2} (\widehat{k})$$

Find the location $\vec{r}$ where the particle comes to a velocity of $\vec{v_f} = 0$ (momentarily at rest).

Solution for Problem 9

10. A steel spring ball launcher such as we use in lab for projectile motion is pointed straight up and fired. The ball takes 6.28 s to reach its maximum height and then return to its starting point. Assuming no air resistance, what is the greatest horizontal distance the ball could travel when launched by the gun?

Solution for Problem 10

11. A batter strikes a baseball when it is 1.20 m above the ground. The bat imparts a velocity of 31.3 $^m/_s$ @ 29.0° above the horizontal. The ball lands on a flat roof that is 9.76 m high. How far did the ball travel horizontally when it landed on the roof?

Solution for Problem 11

12. An airplane is carrying the game ball for a College Bowl game. The plane is flying at a speed of 190.0 $^{km}/_h$ approximately horizontally about 200.0 m above the ground. How many seconds before the plane is directly over the stadium should ball be dropped at rest with respect to the plane? Ignore effects of air resistance.

Solution for Problem 12

13. An object is launched from the ground and is measured to have a velocity of

$$\vec{v} = 52.0 \ \text{m}/_\text{s} \ \widehat{(\imath)} + 12.2 \ \text{m}/_\text{s} \ \widehat{(\jmath)}$$

at a time of t = 2.75 s. Assume the object lands back at the same height it was launched from . Ignore air resistance.

Determine:

    (a)   The horizontal range of the object.

    (b)   The maximum height above the ground the object reaches.

    (c)   The magnitude and direction of the velocity of the object just before it hits the ground again.

Solution for Problem 13

14. A Tik Tok star wants to perform tricks similar to those seen in the "Fast & Furious" movies. As shown below a former parking garage has its far wall gone so that a person who wishes to can drive out of the parking garage and become airborne.
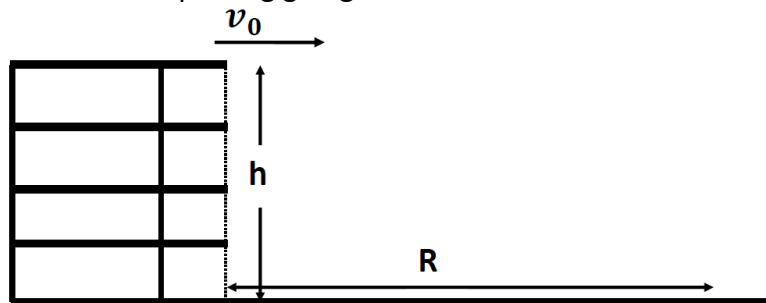
Parking
Garage

Consider a vehicle going off the top floor as shown which is 18.28 m above the ground. Assume the car lands on the ground a distance R = 32.0 m away. In this figure the initial velocity is horizontal. A second case is shown below:
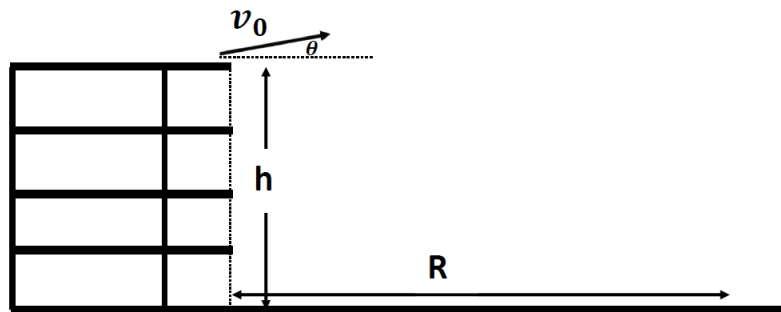

Parking
Garage

In this case, the car encounters a ramp that causes the car to make an angle $\theta = 10.0°$ above the horizontal. Ignore all effects of air resistance. Determine:

(a)   The velocity of the car when it comes out horizontally and lands as indicated R = 32.0 m away.

(b)   The velocity of the car when it comes out at an angle $\theta = 10.0°$ above the horizontal and lands as indicated R = 32.0 m away.

Solution for Problem 14

15. A rock is tossed horizontally from edge of the Grand Canyon with an initial speed of v_0 at time $t = 0$. At each moment, the total velocity vector makes an angle θ with the horizontal direction as shown below. Derive a function relating the angle θ with time t as the rock follows the trajectory caused by gravity. Ignore air resistance.

$$\overrightarrow{v_0}$$

$$\theta$$

$$\vec{v}$$
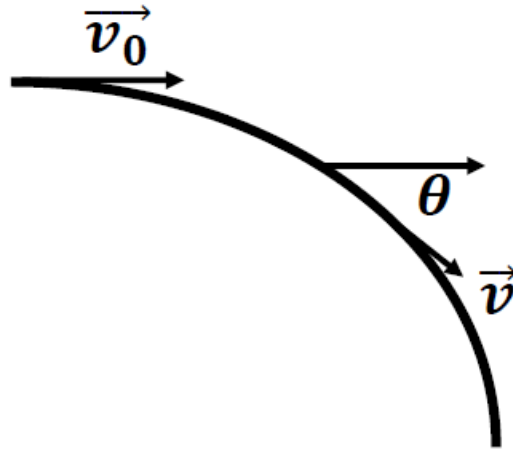
Solution for Problem 15

16. A projectile is launched with an initial speed of 39.9 m/s at an angle of 49.2° above the horizontal on a long clear airport runway. Assume the projectile lands at the same height it was launched from. Ignore effects of air resistance. Determine:

(a) The maximum height reached by the projectile.

(b) The total time the projectile is in the air.

(c) The range covered (horizontal distance traveled).

(d) The velocity of the projectile 1.25 s after the launching of the projectile.
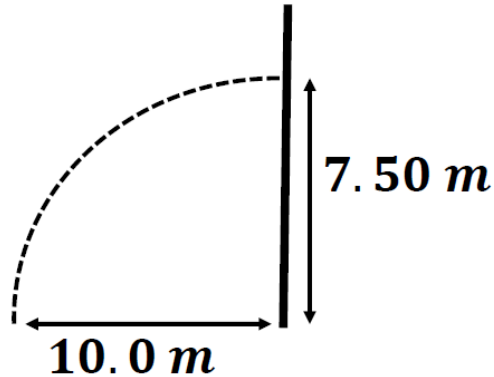
Solution for Problem 16

17. A long jumper jumps at an angle of 29.0° and lands a distance of 9.23 m away. Assume no area resistance. Also assume the landing point is at the same height as the take-off point.

(a) What was the take-off speed?

**(b)** If the take-off speed is increased by 5.00 %, how much longer would the jump distance become?

Solution for Problem 17

18. Carol wants Debbie to sneak out with her. She is standing on the ground $7.50\ m$ below Debbie's window. Carol is also $10.0\ m$ horizontally distant from the window. See the diagram below. Carol wants the pebble she tosses to hit the window only horizontally. What is final speed that the pebble strikes the window with?

$7.50\ m$

$10.0\ m$

Solution for Problem 18

19. A cannon ball is launched as shown below. $7.45\ s$ after it is launched it lands a distance $R = 129.\ m$ away horizontally and up a height $h = 243.\ m.$ Ignore the effects of air resistance and find the magnitude and direction of the initial velocity of the cannon ball at launch.

Landing
Point

$\overrightarrow{v_0}$

h

θ

R
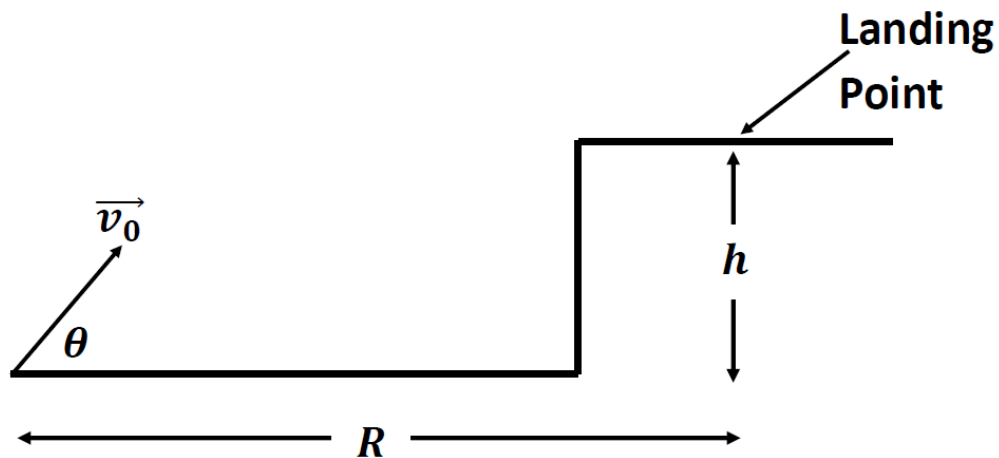
Solution for Problem 19

20. A basketball shot is made with an initial velocity of $\vec{v_0} = 9.50 \ ^m/_s$ @ 55.0° above the horizontal, as shown in the figure below. The ball passes through the hoop which is located a distance (h) of 0.982 m above the point the shot was released.
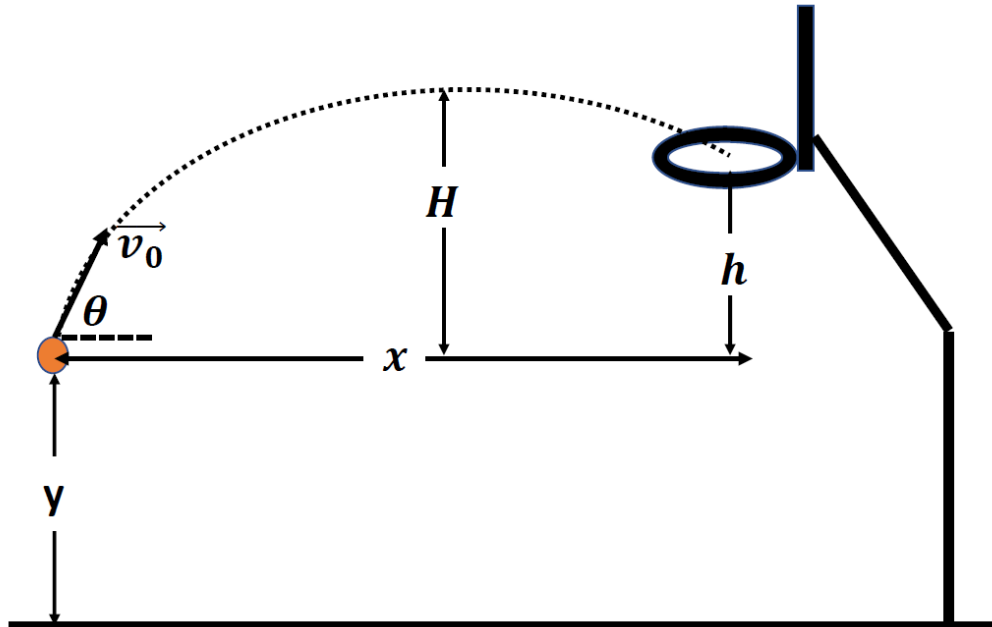
(a)   How far from the basket horizontally (x) was the ball released?

(b)   What is the maximum height (H) above the launch point did the ball rise on its way to the basket?

(c)   What is the magnitude and direction of the basketball as it passes through the hoop?

Solution for Problem 20

Dr. Donovan's Classes Page	**Dr. Donovan's PH 220 Homework Page**
NMU Physics Department Web Page	**NMU Main Page**