PHY2048 Spring 2019 Exam 1 Review Questions

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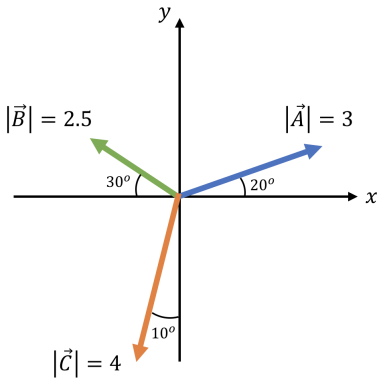
Chapter 1: Vectors



1. Find the x and y components, with their correct signs, of the vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$ shown in the figure above.

2. Consider the vectors:

$$\vec{A} = 2.4\hat{i} + 5.7\hat{j}$$

$$\vec{B} = -\hat{i} + 3\hat{j}$$

   Find the magnitude and direction of each vector.

3. Consider the following vectors:

$$\vec{a} = 3\hat{i} - 2\hat{j} - \hat{k}$$

$$\vec{b} = 4\hat{i} + \hat{j} + 2\hat{k}$$

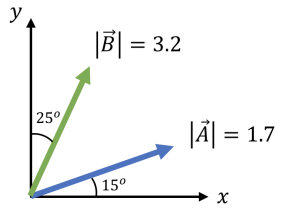
   (a) What is $\vec{a} + \vec{b}$?
   (b) What is $\vec{a} - \vec{b}$?
   (c) What is $3\vec{a} - 2\vec{b}$?

4. Consider the following vectors:

$$\vec{a} = \hat{i} + 4\hat{j}$$

$$\vec{b} = 2\hat{i} + 3\hat{j}$$

   What is the angle between $\vec{a}$ and $\vec{b}$?



5. Consider the vectors in the figure above.
   (a) What is $\vec{A} \cdot \vec{B}$?
   (b) What is $|\vec{A} \times \vec{B}|$?
   (c) What is the direction of $\vec{A} \times \vec{B}$?

6. Consider the following vectors:

$$\vec{A} = 2\hat{i} - 3\hat{j} + \hat{k}$$

$$\vec{B} = -\hat{j} + 4\hat{k}$$

   (a) What is $\vec{A} \cdot \vec{B}$?
   (b) What is $\vec{A} \times \vec{B}$? Give your answer in component form (i.e. using unit vectors, as $\vec{A}$ and $\vec{B}$ were given in this problem).

Chapter 2: Motion Along a Straight Line

1. A jogger runs on a circular track with a radius of 100m. If each lap takes the jogger 100s to complete,
   (a) What is the jogger's average velocity over one lap?
   (b) What is the jogger's average speed over one lap?

2. If an airplane has a take-off speed of 100 m/s, and can accelerate at 15 m/s^2, what is the minimum length of runway the airplane needs to take off? How long will it take the airplane leave the ground?

3. An Olympic sprinter can run the 100m dash in 10s. Assuming the sprinter's acceleration is constant, with what speed does the sprinter cross the finish line? What was the sprinter's acceleration during the run?

4. A car, starting from rest, accelerates at 5 m/s^2 for 4s. Then, the driver brakes the car at 10 m/s^2 until stopped. How far does the car travel during the braking process? How long does it take the car to stop?

5. An object is dropped from the top of a building and is observed to take 7.2s to hit the ground. How tall is the building?

6. If a ball is thrown upwards at 7 m/s, how high will the ball rise? If you catch the ball at the same height which you threw it from, how long would the ball be in the air for?

7. You want to toss an object from the ground up to your friend on a second-story balcony. If your friend is about 4m above you, what minimum initial speed do you have to throw the object up with for it to reach your friend?

8. A ball is dropped from a height of 7m, and bounces off the ground. If the ball leaves the ground with 50% the speed that it hits the ground with, how high will the ball bounce?

9. An object has a position at any time t given by the following function:

$$x(t) = at^3 + bt - c$$

where a, b, and c are constants. What is the velocity of the object at any time t? What is the acceleration of the object at any time t? Could you use kinematics to study the object's motion?

10. An object moves with a position at any time t given by the function:

$$x(t) = (2\text{m/s})t - (13\text{m/s}^2)t^2 + 4\text{m}$$

(a) At what time will the object be at rest?

(b) What will the object's average velocity be from $t = 1$s to $t = 3$s?

(c) What will the object's instantaneous velocity be at $t = 2$s? For this object, the average velocity between any two times should always be equal to the instantaneous velocity midway between the two times; why should this be true?

(d) Could you use kinematics to study this object's motion?

Chapter 3: Motion in Two or Three Dimensions

1. An object has an initial velocity of $\vec{v}_1 = (20m/s)\hat{i} - (10m/s)\hat{j}$. After 5s, the object has a new velocity of $\vec{v}_2 = (15m/s)\hat{j}$. What was the object's average acceleration during these 5s?

2. A projectile is launched at 40^o with a speed of 15 m/s. What is it's height after 0.3s?

3. A projectile is launched at 35^o with a speed of 17.4 m/s from a height of 1m. At what time(s) after launch will the projectile be at a height of 2.5m? *Note: there may be more than one time that the projectile will be at this height.*

4. A projectile is launched horizontally at 12 m/s from a cliff with a height of 15m. How far, horizontally, from the cliff will the projectile hit the ground below?

5. At what angle will a projectile travel a maximum theoretical range if the projectile starts and ends at the same height? At what angle will a projectile reach a maximum theoretical height?

6. A projectile is launched at 50 m/s at an angle of 30^o from the roof of a 20m tall building. At the peak of its trajectory, what is its speed? How high off the ground is the peak? What will the range of this projectile be?

7. An object, initially at rest, moves through outer space, far away from *any planet*, with an acceleration of 4m/s^2 at an angle of 30^o to some imaginary x-axis. If the object starts at rest,

   (a) What distance does it travel along the x-direction in 1s? What about along the y-direction? What total distance does it travel in 1s?

   (b) What is the total speed of the object after 1s?

8. A person rides on a ferris wheel that has a radius of 60m. If the bucket the person sits in travels at 4.5 m/s,

   (a) What is the angular velocity of the ferris wheel?

   (b) What is the centripetal acceleration of the bucket?

   (c) How long does it take the ferris wheel to complete one revolution?

Answers

Chapter 1

1. $A_x = 2.8$, $A_y = 1.0$, $B_x = -2.2$, $B_y = 1.3$, $C_x = -0.7$, $C_y = -3.9$
2. $|\vec{A}| = 6.2$, $\theta_{\vec{A}} = 67^o$ (counterclockwise from the x-axis), $|\vec{B}| = 3.2$, $\theta_{\vec{B}} = 108^o$ (counterclockwise from the x-axis)
3. (a) $\vec{a} + \vec{b} = 7\hat{i} - \hat{j} + \hat{k}$
   (b) $\vec{a} - \vec{b} = -\hat{i} - 3\hat{j} - 3\hat{k}$
   (c) $3\vec{a} - 2\vec{b} = \hat{i} - 8\hat{j} - 7\hat{k}$
4. 19.7^o
5. (a) $\vec{A} \cdot \vec{B} = 3.50$
   (b) $|\vec{A} \times \vec{B}| = 4.17$
   (c) $\vec{A} \times \vec{B}$ points out of the page
6. (a) $\vec{A} \cdot \vec{B} = 7$
   (b) $\vec{A} \times \vec{B} = -11\hat{i} - 8\hat{j} - 2\hat{k}$

Chapter 2

1. (a) 0
   (b) 6.28 m/s
2. 337m, 6.7s
3. 20 m/s, 2 m/s^2
4. 20m, 2s
5. 259.2m
6. 2.5m, 0.71s
7. 8.9 m/s
8. 1.75m
9. $v(t) = 3at^2 + b$, $a(t) = 6at$, no
10. (a) 0.08s
    (b) -50 m/s
    (c) -50 m/s
    (d) Yes

Chapter 3

1. $\vec{a}_{av} = -(4 \text{ m/s}^2)\hat{i} + (5 \text{ m/s}^2)\hat{j}$
2. 2.4m
3. $t_1 = 0.16$s, $t_2 = 1.84$s
4. 20.8m
5. 45^o, 90^o
6. 43 m/s, 51m, 5.7s
7. 1.73m, 1m, 2m
8. 4 m/s
   (a) 0.075 rad/s
   (b) 0.34 m/s^2
   (c) 83.8s