PHY2048 Spring 2019 Exam 1 Review Questions

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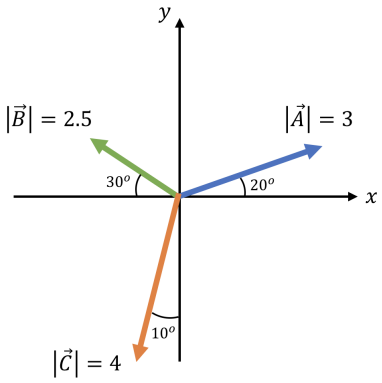
Chapter 1: Vectors



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:

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

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

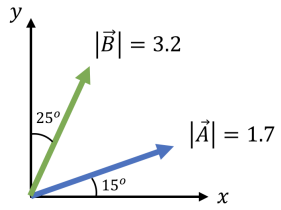
   (a) What is $\vec{a} + \vec{b}$?
   (b) What is $\vec{a} - \vec{b}$?
   (c) What is $3\vec{a} - 2\vec{b}$?

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?

Chapters 4 & 5: Forces

1. What are Newton's three laws of motion?

2. A 4.7kg box is pulled to the right along a rough floor by a horizontal rope. While the box moves, the floor is putting a friction force on the box of 23N to the left.

   (a) Draw the free body diagram of object

   (b) If the box moves with a constant velocity, what would be the tension in the rope pulling it?

   (c) If the box accelerates at $2.5\ \text{m/s}^2$, what would be the tension in the rope pulling it?

   (d) Suppose that the tension in the rope was 50N. How far would the box travel after 1.5s of pulling it?

3. An 5kg object at rest on a surface experiences a weight downwards of 49N, and an equal normal force of 49N upwards. These forces form an action-reaction pair as defined by Newton's third law.

   (a) True

   (b) False

4. A person pulls a 7kg box along the floor with a rope attached to the box. If the person pulls the box with a force of 100N, and the rope makes an angle of 40^o above the horizontal axis,

   (a) What is the normal force on the box?

   (b) What is the acceleration of the box?

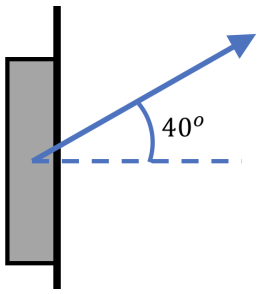
5. Three forces act on a 5kg object: a force $\vec{F}_1$ with a magnitude of 10N at an angle of 20^o above the x axis, a force $\vec{F}_2$ with a magnitude of 30N at an angle of 60^o below the x axis, and a force $\vec{F}_3$ with a magnitude of 25 N pointing along the $-x$ axis.

   (a) What is the magnitude of the net force?

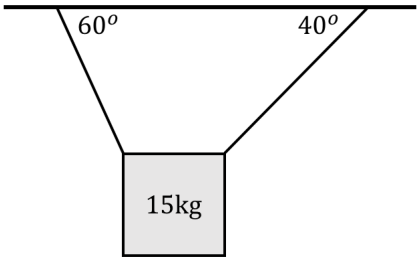
   (b) What is the angle, measured counter-clockwise from the x axis, of the net force?

   (c) What is the magnitude of the acceleration?

   (d) What is the angle, measured counter-clockwise from the x axis, of the acceleration?



6. A 1kg book is pressed against a wall with a force F made with a 40^o angle from the horizontal, as shown in the figure above, such that the book doesn't move. If the wall is **frictionless**,
   (a) What must the force F be?
   (b) What must the normal force on the book be?



7. What is the tension in each of the ropes shown in the figure above? Assume that the box is at rest hanging from the ropes.

8. A 500g ball is being spun in a circle at the end of a 75cm string in the horizontal plane. If the maximum tension the string can withstand is 500N, what is the maximum speed at which that the ball can move without breaking the string?

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

Chapters 4 & 5

1.
2.