PHY2048 Spring 2018 Exam 1 Review Questions

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Chapter 2: Motion Along a Straight Line

1. A car moves at a speed of 30m/s when suddenly the driver brakes the car at 12m/s^2. How far will the car travel until it stops? How long will it take the car to stop?

2. An Olympic sprinter can run the 100m dash in 10s. What must the acceleration of the sprinter be during this run, if we assume that the acceleration is constant? What is the final speed of the sprinter when he or she crosses the finish line?

3. A car accelerates from rest at 10m/s^2 for 5s, then brakes at a rate of 15m/s^2 until it stops again. How far does the car travel during this motion? Graph the car's position vs. time and velocity vs. time during this motion.

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

5. 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? Assume that you throw the object straight upwards.

6. A car is speeding, doing 40m/s in a 35m/s zone, when it passes by a police car. If the police car is at rest, but accelerates at 10m/s^2, how long will it take for the police car to catch up to the speeding car? How far will they both travel during this time?

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

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

where $a = 10\text{m/s}^3$, $b = 5\text{m/s}$, and $c = 6\text{m}$. 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?

8. An object has a velocity at any time t given by the following equation:

$$v(t) = at\sqrt{t^2 + 1}$$

where a is some constant. What would the object's acceleration be at any time t? What would the object's displacement be from 0 to any time t?

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

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

At what time will the object be at rest? Does this object move with a constant or non-constant acceleration? Could you use kinematics to study the motion of this object?

Chapter 3: Vectors

1. Consider the following vectors:

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

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

   What is $\vec{c} = \vec{a} + \vec{b}$? Express $\vec{c}$ in vector notation, as vectors $\vec{a}$ and $\vec{b}$ above.

2. Consider the same vector $\vec{c}$ as in the previous problem. What is the magnitude of $\vec{c}$? What about its direction, measured counterclockwise from the positive x-axis?

3. 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 $\vec{b}$?

4. Consider three vectors: $\vec{a}$, $\vec{b}$, and $\vec{c}$. The magnitude of $\vec{a}$ is 10, and its angle is 25^o; the magnitude of $\vec{b}$ is 5, and its angle is 10^o; and the magnitude of $\vec{c}$ is 8, and its angle is 50^o. All angles are measured counterclockwise from the positive x-axis.

   (a) What is the x-component of $\vec{a} + \vec{b} - \vec{c}$?

   (b) What is the y-component of $\vec{a} + \vec{b} - \vec{c}$?

   (c) What is the magnitude of $\vec{a} + \vec{b} - \vec{c}$?

   (d) What is the direction of $\vec{a} + \vec{b} - \vec{c}$, measured counterclockwise from the positive x-axis?

5. Consider the following vectors:

$$\vec{a} = -5\hat{i} - 6\hat{j}$$

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

   What is $|\vec{a} \times \vec{b}|$? Note that this is the *magnitude* of the cross product, not the cross product itself.

Chapter 4: Motion in Two and Three Dimensions

1. A projectile is launched at 30^o with a speed of 25 m/s. What is the height of the projectile after 0.5s?

2. A projectile is launched at 42^o with a speed of 35 m/s from a height of 1m. At what time(s) after launch will the projectile be at a height of 2m? *Note: there may be more than one time that the projectile will be at this height.*

3. A projectile is launched horizontally at 15 m/s from a cliff with a height of 10m. How far from the cliff will the projectile hit the ground below?

4. At what angle will a projectile achieve a maximum theoretical range, assuming the projectile starts and ends at the same height? *Note: you must provide a mathematical justification for your answer; physical reasoning alone will not be sufficient proof.*

5. An object moves through space 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?

Chapter 5 & 6: Newton's Laws and their Applications

1. An object at rest on a flat surface has a weight and normal force which are equal in magnitude and opposite in direction. These forces form an action/reaction pair as defined by Newton's third law.

   (a) True

   (b) False

2. A person pushes a 5kg box along the floor with a force of 150N along the x direction.

   (a) If a resistive force of 50N along the $-x$ direction pushes against the person, what is the acceleration of the box?

   (b) If a resistive force of 50N along the $-x$ direction pushes against the box, what is the acceleration of the box?

3. 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?

4. 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?

5. A man pushes a 3kg box along the floor with a 120N force.

   (a) What should the acceleration of the box be?

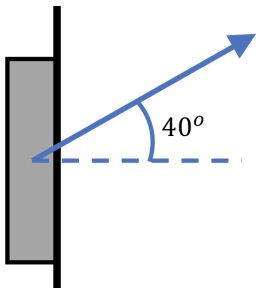
   (b) Let's say that friction acts on the box to reduce the acceleration to 35m/s^2. What would the force of friction be?

   (c) What, then, would the coefficient of friction be?

6. When braking, a 1500kg car going 30 m/s will stop in 50m. What is the coefficient of friction between the tires and the road?

7. A 5kg box is pushed up a ramp with an incline angle of 30^o. If the box has an initial speed of 20m/s, how far up the ramp (i.e. the final height of the box) does the box reach? Note that the coefficient of friction between the box and the ramp is 0.35.

8. A 1kg book is pressed against a wall with a force of 40N made with a 40^o angle from the horizontal, as shown in the figure below, such that the book remains at rest against the wall. What type of friction keeps the book against the wall? What is the magnitude of that friction force? Note that the coefficient of static friction is 0.5 and the coefficient of kinetic friction is 0.4.



9. As shown in the figure below, box A, with a mass of 5kg, is pushed with a force $\vec{F}$. Box B, with a mass of 2kg, is placed in front of box A such that they move together.

   (a) If the coefficient of static friction is 0.4 between both boxes and the floor, what is the minimum force $\vec{F}$ needed to get the boxes moving?

   (b) If the coefficient of kinetic friction is 0.3 between both boxes and the floor, what is the magnitude of $\vec{F}$ required to keep the boxes moving at a constant speed?

   (c) If the boxes are moving at a constant speed, what is the force that box B puts on box A?