PHY2048 Spring 2018 Homework Assignment #1

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Abstract

In this homework assignment, you're going to be solving problems on the various forms of mathematics we reviewed in the first couple of lectures, as well as basic definition in kinematics. This homework set is due **January 29**.

1. If an object moves with a position $x(t) = 3t^2 \ln(t/t_0)$, where t_0 is some constant, what is the object's velocity with respect to time? The object's acceleration with respect to time?.

2. An object moves with a velocity of $v(t) = (3\ \mathrm{m/s^3})t^2 - (4\ \mathrm{m/s^2})t$. What is the object's displacement from 0 to 4?

3. Consider a velocity $v(t) = be^{-at}$. If $v(1\mathrm{s}) = 20$ m/s and $v(2\mathrm{s}) = 15$ m/s, what are the values of a and b? What is the physical meaning of the value b? *Hint: don't consider $v(t)$ for $t = 0$, but consider it for very large t.*

4. Consider three vectors:

$$\vec{a} = \hat{i} + 3\hat{j}$$

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

$$\vec{c} = 5\hat{j}$$

   Given these vectors, compute the following quantities:

   (a) $\vec{d} = \vec{a} + \vec{b} + \vec{c}$
   (b) θ, the angle between $\vec{a}$ and $\vec{b}$
   (c) ϕ, the angle of $\vec{d}$ measured **counter-clockwise** from the $+x$-axis.

5. Consider the two vectors:

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

$$\vec{B} = 6\hat{j} + \hat{k}$$

   Compute the following quantities:

   (a) $|\vec{A} + \vec{B}|$
   (b) $\vec{A} \cdot \vec{B}$
   (c) $\vec{A} \times \vec{B}$

(d) θ, the angle between $\vec{A}$ and $\vec{B}$

6. (**Extra Credit**) Consider the two vectors:

$$\vec{A} = 4\hat{i}$$

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

(a) Draw the two vectors in an xy-coordinate system.

(b) Define the **projection of $\vec{B}$ onto $\vec{A}$** as the length of $\vec{B}$ that runs parallel to $\vec{A}$. What is the projection of $\vec{B}$ onto $\vec{A}$ in this case? To help visualize what the projection of a vector represents, imagine an *actual* projector shining a light on a plank of wood, as shown in the following figure. The shadow of that plank of wood is what the projection projection represents. However, to imagine a vector in this analogy, we'd need the width of the board to be zero; so the projection of a vector (the plank of wood) onto another vector (the wall) is analogous to the *height/length* of the shadow.