

~~2.9 Unit Vectors~~

~~Find two unit vectors which are perpendicular to both $2\hat{x} - 3\hat{y}$ and $-\hat{x} + 4\hat{y} - 5\hat{z}$.~~

~~2.10 Position, Speed, Velocity, and Acceleration.~~

~~A particle is moving in three dimensions. Its position vector, \mathbf{r} , is given by~~

$$\mathbf{r} = (6 - 2t)\hat{x} + (3 + 4t - 6t^2)\hat{y} - (1 + 3t - 2t^2)\hat{z}$$

~~Distances are in meters, and the time, t , in seconds.~~

- ~~What is the velocity vector at $t = +3$?~~
- ~~What is the speed at $t = +3$?~~
- ~~What is the acceleration vector and what is its magnitude at $t = +3$?~~

~~2.11 Stunt Driver~~ page 93, problem 10.

~~2.12 Golf~~ page 94, problem 24.

~~2.13 Ski Jump~~ page 95, problem 30.

~~2.14 Centripetal Acceleration~~ page 96, problem 45.

~~2.15 Centripetal Acceleration of Planets in our Solar System~~ page 97, problem 49.

~~Try: <http://ask.com>, and ask the question "what is the distance to our planets?"~~

~~You can find distances, rotational periods, orbital periods, mean orbital velocities, masses, sizes, and much more for all our planets.~~

~~2.16 Roundtrip by Plane.~~

~~An airplane makes a roundtrip between A and B (starting at A). Will the roundtrip take longer without wind or with wind? Assume that the wind is blowing in the direction from A to B . Before you make any calculations use your intuition and make a guess.~~

~~Let the distance between A and B be d , the speed of the plane relative to air be v , and the speed of the wind be w . What would happen if the wind speed became so high that $w = v$? How would your answer change if the wind were blowing in the direction from B to A ?~~

~~Reminder.~~

~~There are 26 recitation sections. If you want to change, for whatever reason, please go to the physics education office (4 352).~~

Problem 2.10

The position as a function of time is given as

$$\vec{r} = (6 - 2t)\hat{x} + (3 + 4t - 6t^2)\hat{y} - (1 + 3t - 2t^2)\hat{z}$$

(a) The velocity vector at any time t is given by

$$\begin{aligned}\vec{v} &= \frac{d\vec{r}}{dt} \\ &= \frac{d}{dt}(6 - 2t)\hat{x} + \frac{d}{dt}(3 + 4t - 6t^2)\hat{y} - \frac{d}{dt}(1 + 3t - 2t^2)\hat{z} \\ &= (-2)\hat{x} + (4 - 6(2)t)\hat{y} - (3 - 2(2)t)\hat{z} \\ &= -2\hat{x} + (4 - 12t)\hat{y} - (3 - 4t)\hat{z}\end{aligned}$$

So in particular at $t = 3$,

$$\begin{aligned}\vec{v} &= -2\hat{x} + (4 - 12(3))\hat{y} - (3 - 4(3))\hat{z} \\ &= -2\hat{x} - 32\hat{y} + 9\hat{z}\end{aligned}$$

(b) The speed at $t = 3$ is given by the magnitude of \vec{v} at $t = 3$ which is

$$|v| = \sqrt{(-2)^2 + (-32)^2 + (9)^2} = \sqrt{1109} = 33.3$$

So the speed is 33.3 m/s.

(c) The acceleration vector at any time t is given by

$$\begin{aligned}\vec{a} &= \frac{d\vec{v}}{dt} \\ &= \frac{d}{dt}(-2)\hat{x} + \frac{d}{dt}(4 - 12t)\hat{y} - \frac{d}{dt}(3 - 4t)\hat{z} \\ &= (0)\hat{x} + (-12)\hat{y} - (-4)\hat{z} \\ &= -12\hat{y} + 4\hat{z}\end{aligned}$$

So in particular at $t = 3$

$$\vec{a} = -12\hat{y} + 4\hat{z}$$

The magnitude of \vec{a} at $t = 3$ is

$$|a| = \sqrt{(0)^2 + (-12)^2 + (4)^2} = \sqrt{160} = 12.6$$

So the magnitude of acceleration at $t = 3$ is 12.6 m/s².