Chapter 3: Kinematics in Two Dimensions; Vectors

- 3-1 Vectors and Scalars
- 3-2 Addition of Vectors—Graphical Methods
- 3-3 Subtraction of Vectors, and Multiplication of a Vector by a Scalar
- 3-4 Adding Vectors by Components
- 3-5 Projectile Motion
- 3-6 Solving Problems Involving Projectile Motion

Addition of vectors
Two displacements
$$\vec{D}_1 = B \text{ km east}$$

 $\vec{D}_2 = 6 \text{ km month}$
• Addition
• graphically : tail-to-head (tail to +ip)
• generative to any 2,3 etc vectors.

- Subtraction
- * Authin pla calmai

•) Resolving rector into components

$$\vec{V} = \vec{V}_{x} + \vec{V}_{y}$$

these are mutually perpendicular
 $V = the densities of \vec{V}_{y}$
 $\vec{V}_{x} = the densities of \vec{V}_{y}$
 $\vec{V}_{y} = -n - n \vec{V}_{y}$
 $\vec{V}_{y} = 3.0 \text{ m}$



chearing
$$V_X = V_{1,X} + V_{2,X}$$

 $V_{1,Y} = V_{1,Y} + V_{2,Y}$ extension

EXAMPLES : see projectile motion

Three vectors \vec{A} , \vec{B} , and \vec{C} are as shown. Which vector is $\vec{S} = \vec{A} + \vec{B} - \vec{C}$?



Purple: None of these!

The position vector of a particle moving with constant velocity is shown below at two different times, an earlier time t_1 and a later time t_2 . Which arrow shows the direction of the velocity vector?



Purple: None of these!



The velocity vector of a particle moving with constant acceleration is shown below at two different times, an earlier time t_1 and a later time t_2 . What is the direction of the acceleration vector?



Purple: None of these!



A <u>barrel</u> of a rifle <u>points</u> straight at a monkey hanging from a branch of a tree. The instant the gun is fired, the monkey releases a grip on the branch and starts falling. The initial speed of the bullet is v_o , and the monkey is well within the range of the rifle for this value of v_o . What happens?



- a) Bullet finds its target.
- b) Bullet hits the monkey only if v_o is large enough.
- c) Bullet misses.

A particle is moving along the path shown, with constant speed. Its velocity vector at two different times is shown. What is the direction of the acceleration when the particle is at point A?



Purple: the acceleration is zero.

Kicking a football

You kick a football, giving it initial velocity of 20 % in the direction of 37° above the ground. How far does it land? How high does it go?



Two projectiles are <u>simultaneously</u> fired from two different cannons with the same initial speed, and both hit the same target, as shown. For projectile B, the cannon is tilted upward at the angle of 25 degrees above the horizontal.



Question 1: At what angle was the cannon tilted for the projectile A?

- a) 55 degrees
- b) 60 degrees
- c) 70 degrees
- d) 75 degrees
- e) None of the above

Question 2: Which projectile hits the target first?

- a) A
- b) B
- c) Both hit at the same time
- d) Not enough information given.

Two projectiles are fired one after another from a cannon. For projectile A, the cannon is tilted upward at an angle larger that of projectile B. (As usual, neglect air resistance.)



Which projectile was in the air <u>longer</u>?

- a) A
- b) B
- c) A and B were in the air the same length of time.
- d) Not enough information to answer the question.