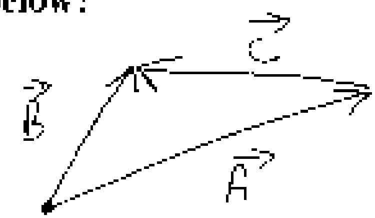
PHYSICS 1A SPRING 2001 READING QUIZ 1.

1. Which of these is the correct expression for the vector **C** in the diagram below?



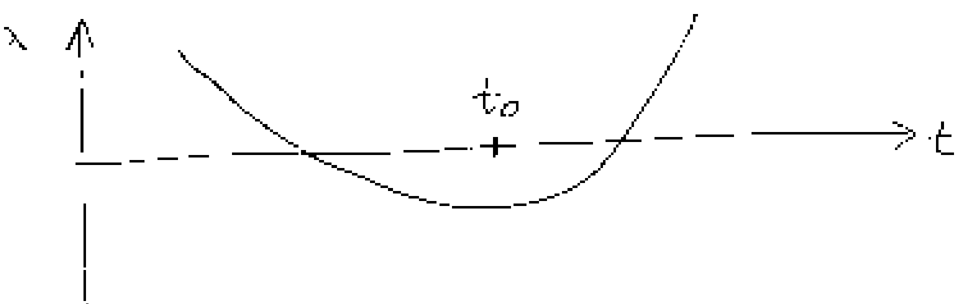
a) $\vec{C} = \vec{A} + \vec{B}$

b) $\vec{C} = \vec{A} - \vec{B}$

c) $\vec{C} = -(\vec{A} + \vec{B})$

d) $\vec{C} = \vec{B} - \vec{A}$ since $\vec{B} + \vec{C} = \vec{A}$

2. The (speed, acceleration) of an object following the position/time curve below is, at time t_0:



a) positive, positive

b) positive, zero

c) zero, positive

d) zero, negative

$\frac{dx}{dt} = 0$, $\frac{d^2x}{dt^2} > 0$ (concave upwards)

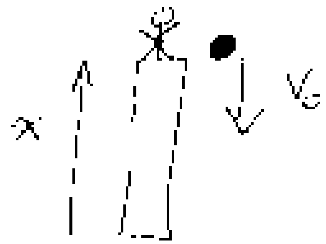
3. A rock is thrown downwards from a tower. Shortly after release, neglecting air friction, it's downward acceleration:

a) is greater than g.

b) is equal to g.

c) is less than g.

d) depends on how fast it is thrown.



accel. $= -g$, independent of speed v_0

speed $v = v_0 - gt$

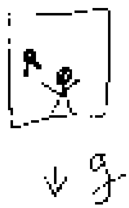
4. You are in an elevator when the support cable breaks and the elevator begins to free-fall. In a fright, you let go of your keys giving them a small upwards push. On the way down your keys will:

a) eventually drop to the floor.

b) eventually float up to the ceiling.

c) float up a small distance (eye level) and remain there.

d) accelerate and slam into the ceiling.



All objects in free fall accelerate at $(-g)$

As viewed from ground:

elevator (and you) have $v_e = -gt$ $(= 0 \text{ at } t = 0)$

keys have $v_k = v_0 - gt$ (= upwards v_0 at $t = 0$)

$\therefore$ In reference frame of elevator,

keys have relative speed $v_k - v_e = v_0 - gt + gt$

$= v_0$, constant

Position and Motion in >1D: Vectors

To specify position of object w.r.t. origin we need <u>distance</u> and <u>direction</u>

A vector is an arrow in space

- has <u>magnitude</u> and <u>direction</u>

<u>Displacement vector $\vec{s}$</u> locates an object wrt origin (regardless of path taken).

e.g. turtle leaves starting point P_0 some time later at P_f

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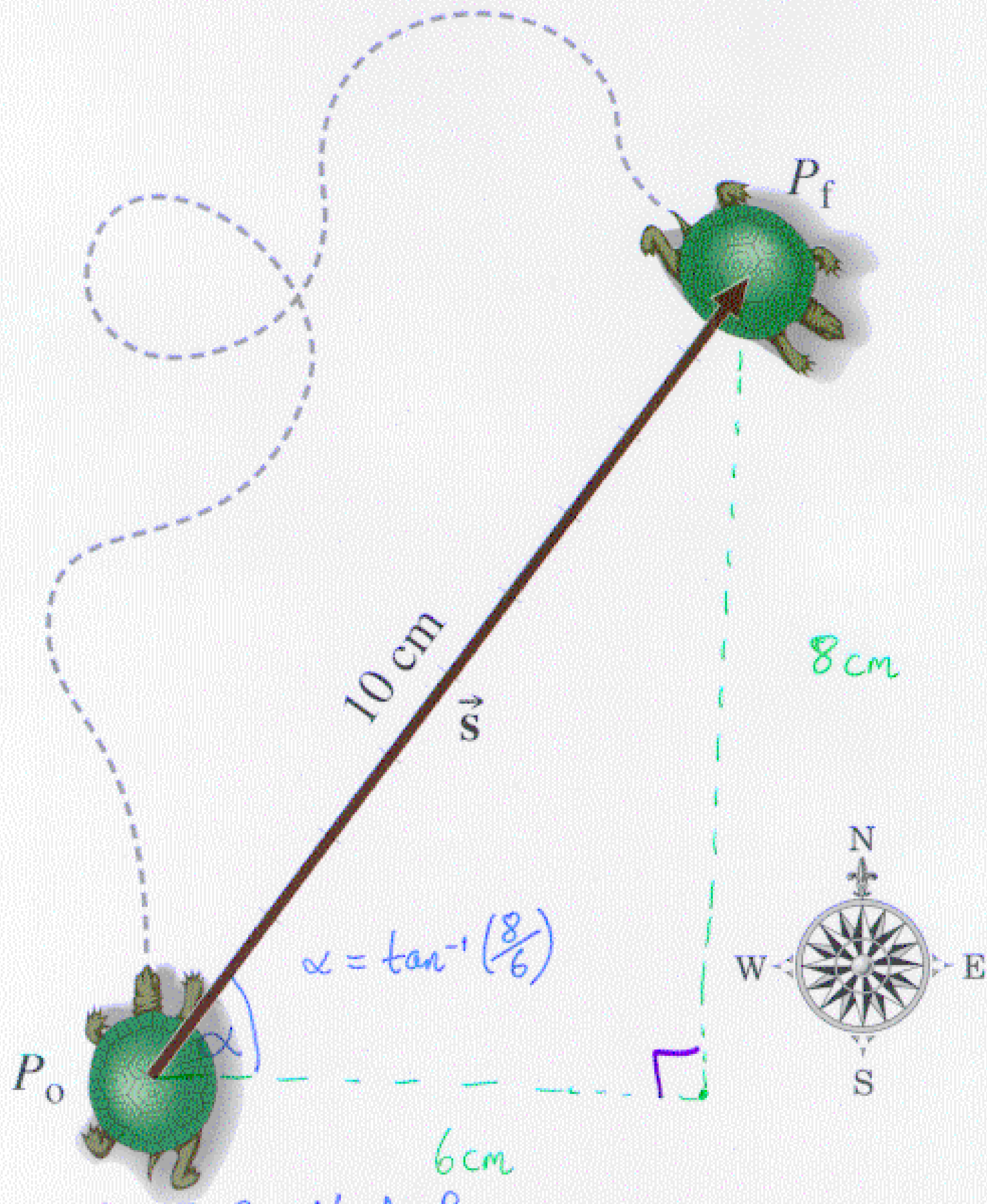
Figure 2.13

Displacement of meandering turtle



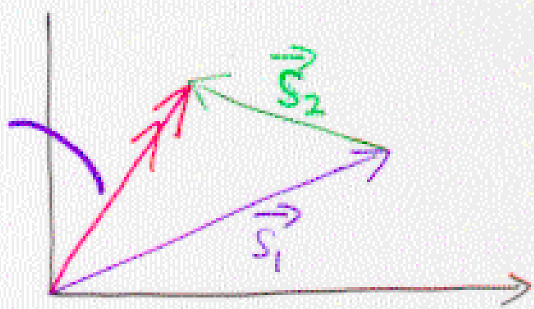
P_f is 6cm E, 8cm N of P_o

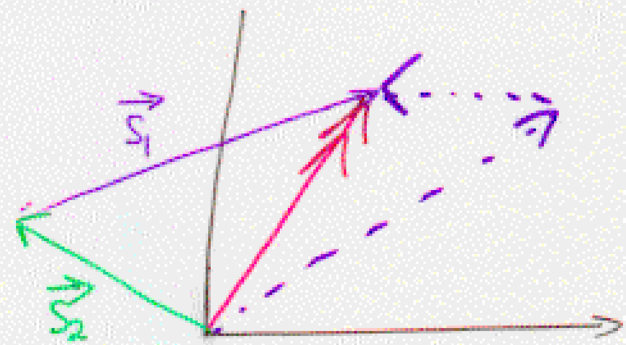
<u>OR</u> P_f is 10cm from P_o at bearing 56.1° N of E

Vector Algebra : Addition, Subtraction, Multiplication

e.g. Program toy robot to move by successive displacements $\vec{s}_1, \vec{s}_2$
(give bearing and distance → specifies each $\vec{s}$).

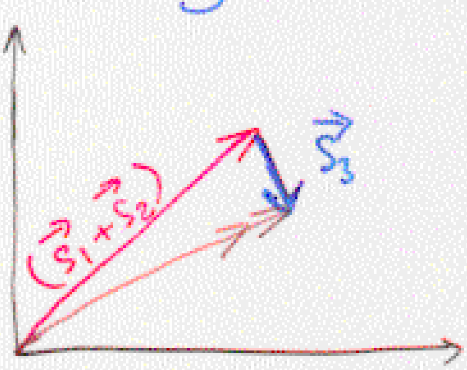
$\vec{S} = \vec{S}_1 + \vec{S}_2$

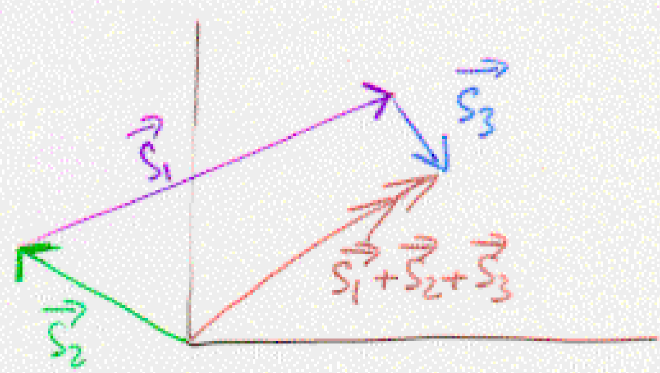




To find resultant displacement,

- add $\vec{s}_1, \vec{s}_2$ "tip-to-tail", resultant = arrow from tail of first vector to tip of last
- Order not important! $\vec{s}_1 + \vec{s}_2 = \vec{s}_2 + \vec{s}_1$
- Can add any number of vectors tip-to-tail:



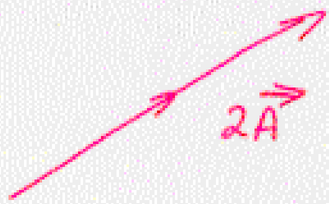


Example 2.6 (treasure map)

Negation, Subtraction, Multiplication etc.

For any vector $\vec{A}$ (e.g. displacement $\vec{s} = \vec{A}$):

- Add $\vec{A} + \vec{A} = 2\vec{A}$: doubles length, same direction



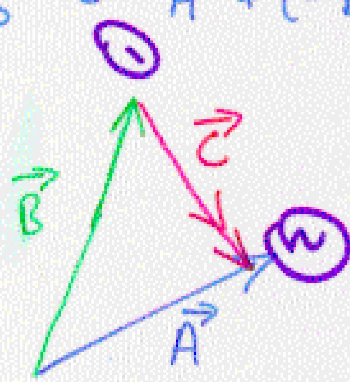
Can also have $1.5\vec{A}$, $0.1\vec{A}$ etc.

- Subtract $\vec{A} - \vec{A} = 0$: for this to work, $-\vec{A}$ has opposite direction to $\vec{A}$:

can also form $-1.5\vec{A}$, $-0.1\vec{A}$ etc.

$\therefore$ For two vectors $\vec{A}, \vec{B}$ can form difference

$$\vec{C} \equiv \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$



To draw: since $\vec{C} = \vec{A} - \vec{B}$

then $\vec{A} = \underbrace{\vec{B} + \vec{C}}_{\text{tail-to-tip}}$

Note: $\vec{A}, \vec{B}$ may depend on choice of origin but $\vec{C} = \vec{A} - \vec{B}$ does not (fig 2.23)

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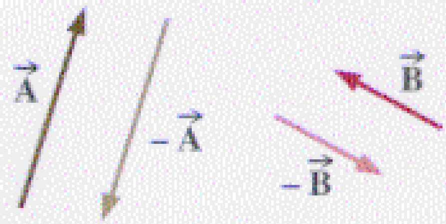
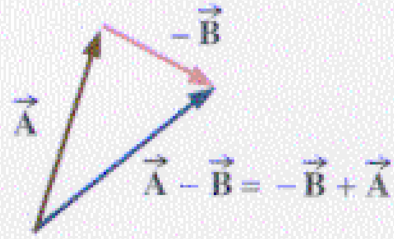
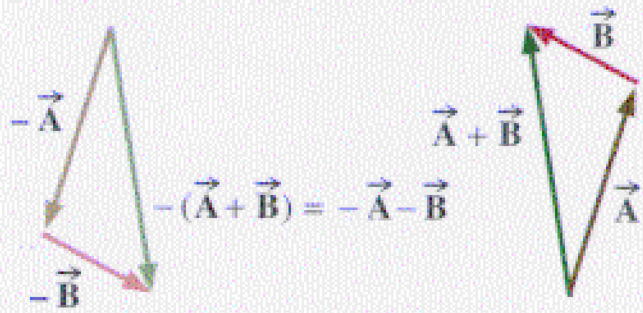
Figure 2.19
Sum and difference of two vectors



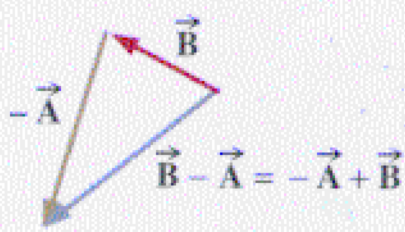
(a)



(b)



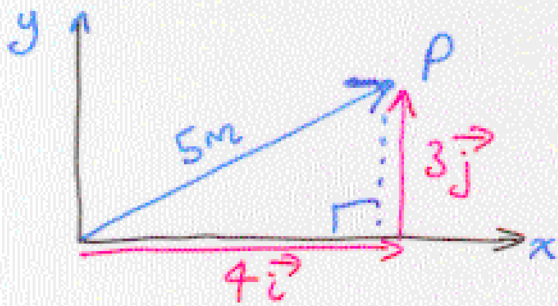
(c)



(d)

Vector Components :

Can express any vector as sum of two (2D) or three (3D) orthogonal vectors along (x, y, z) axes :

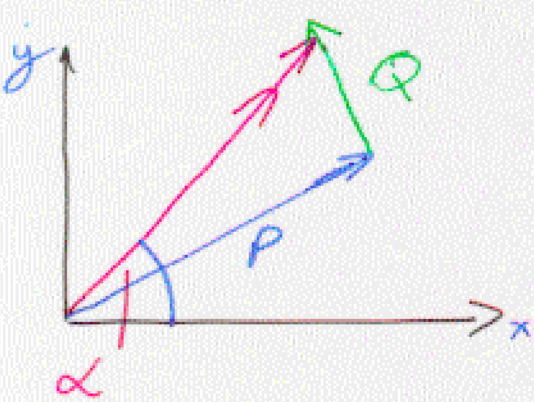


e.g. $\vec{P} = 4\vec{i} + 3\vec{j} + 0\vec{k}$

where $(\vec{i}, \vec{j}, \vec{k})$ are unit vectors along (x, y, z) axes.

Makes vector addition/subtraction easier - just add/subtract components :

$$\vec{P} = x\vec{i} + y\vec{j} + z\vec{k}$$



e.g. $\vec{P} = 4\vec{i} + 3\vec{j}$

$Q = -1i + 2\vec{j}$

$\Rightarrow \vec{P} + \vec{Q} = (4-1)\vec{i} + (3+2)\vec{j}$

$(\vec{P} + \vec{Q}) = 3\vec{i} + 5\vec{j}$

In general, for vector $x\vec{i} + y\vec{j} + z\vec{k}$

Magnitude $= \sqrt{x^2 + y^2 + z^2} = \sqrt{3^2 + 5^2 + 0^2} = 5{\cdot}83$

Direction wrt x axis $= \tan^{-1}(y/x) = \tan^{-1}(5/3) = 59{\cdot}03°$