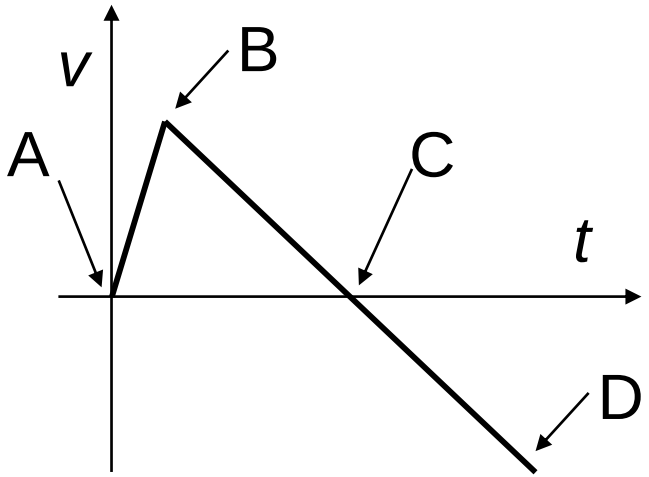
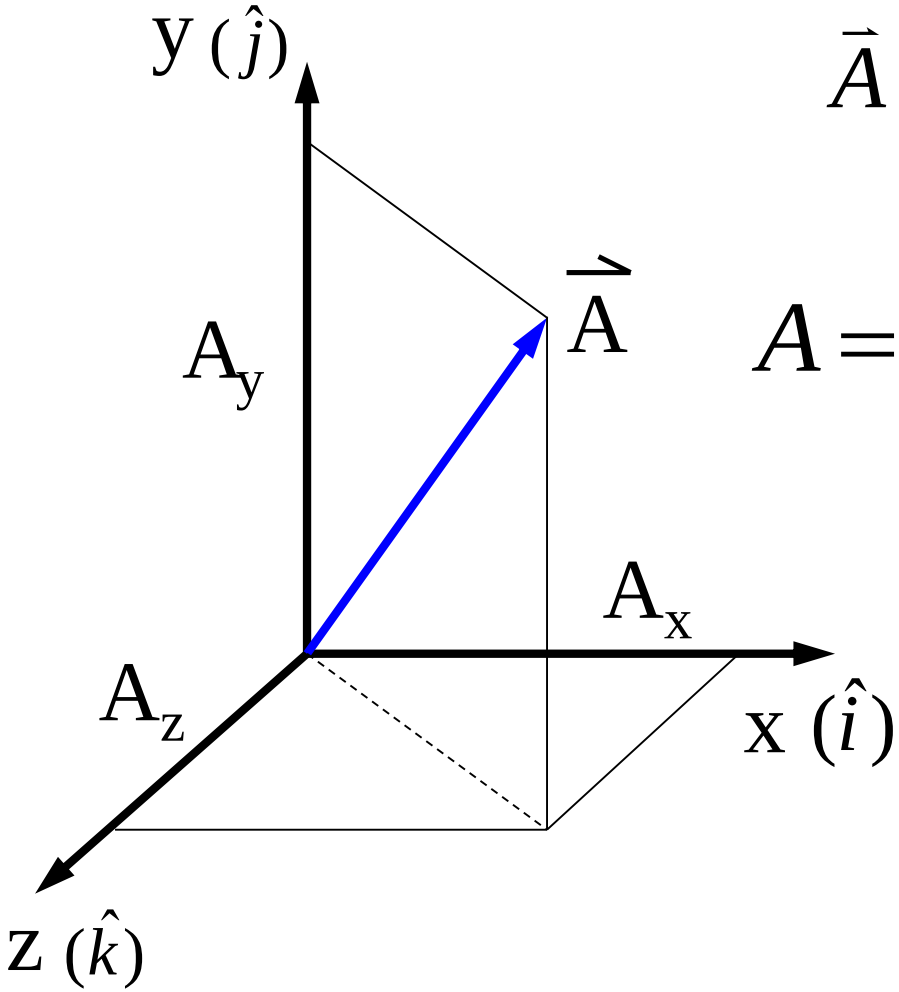
Think about a motion picture that would result in the v-t diagram shown below. You may ignore air resistance in all situations.



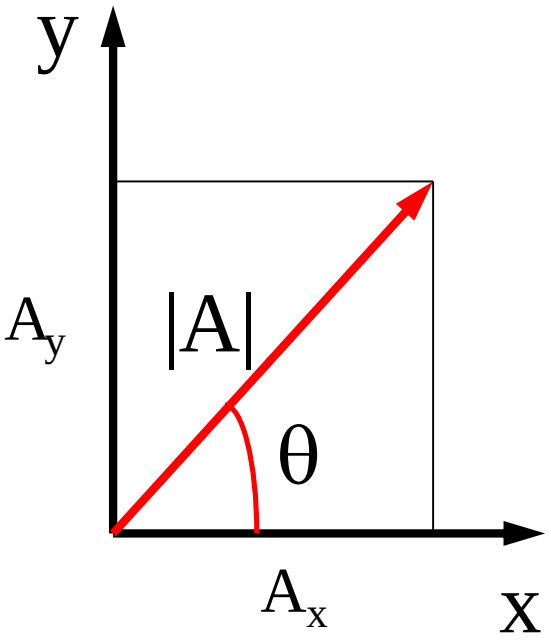


$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$A = \left|\vec{A}\right| = \sqrt{(A_x^2 + A_y^2 + A_z^2)}$$

$$\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{k}$$

In 2-Dimension



$$\vec{A} = A_x \hat{i} + A_y \hat{j}$$

$$A_x = A\cos\theta$$

$$A_y = A\sin\theta$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$|A| = \sqrt{A_x^2 + A_y^2}$$

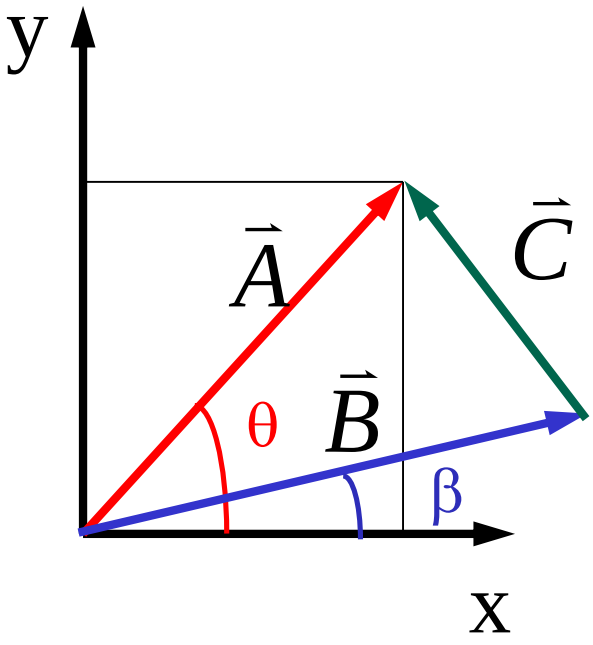
$$\theta = \arctan\left(\frac{A_y}{A_x}\right)$$

$$\vec{A}+\vec{B}=\vec{B}+\vec{A}$$ (commutative)

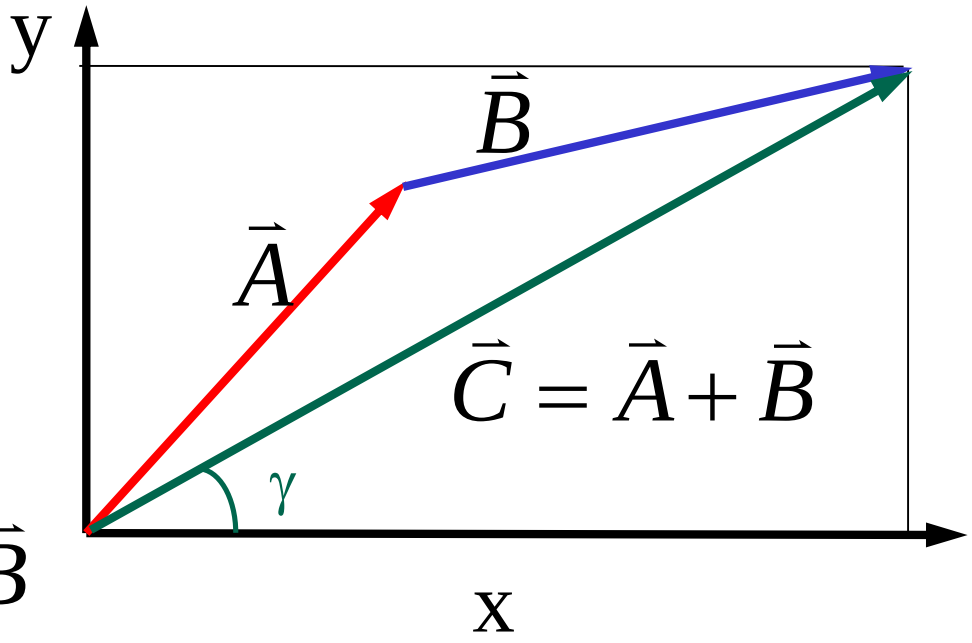
(associative)

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

In 2-Dimension



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

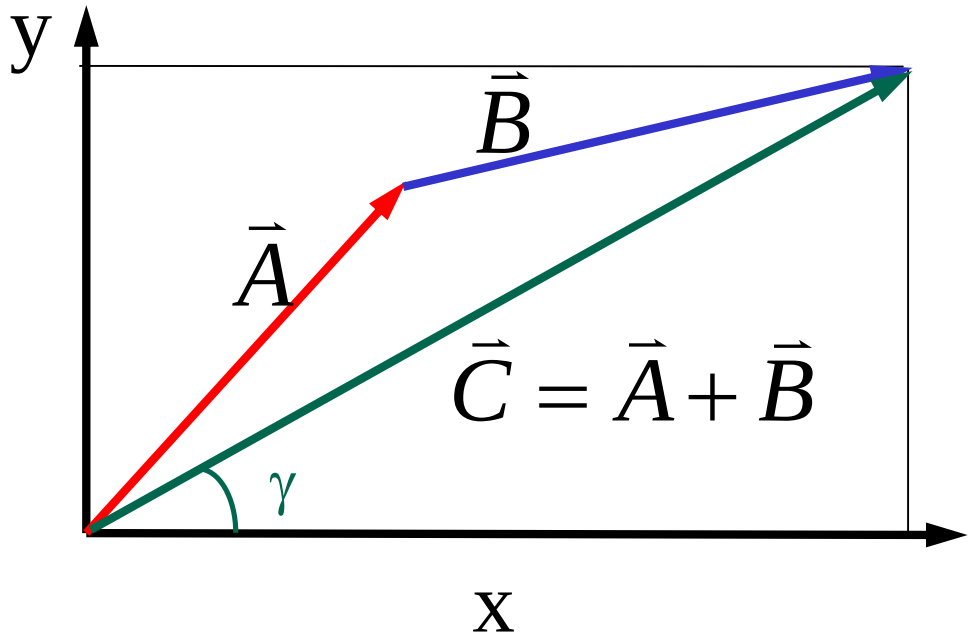


$$\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$

$$\vec{A} - \vec{B} = (A_x - B_x)\hat{i} + (A_y - B_y)\hat{j}$$

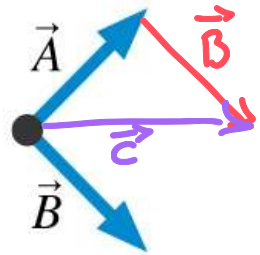
γ=?

|C|=?



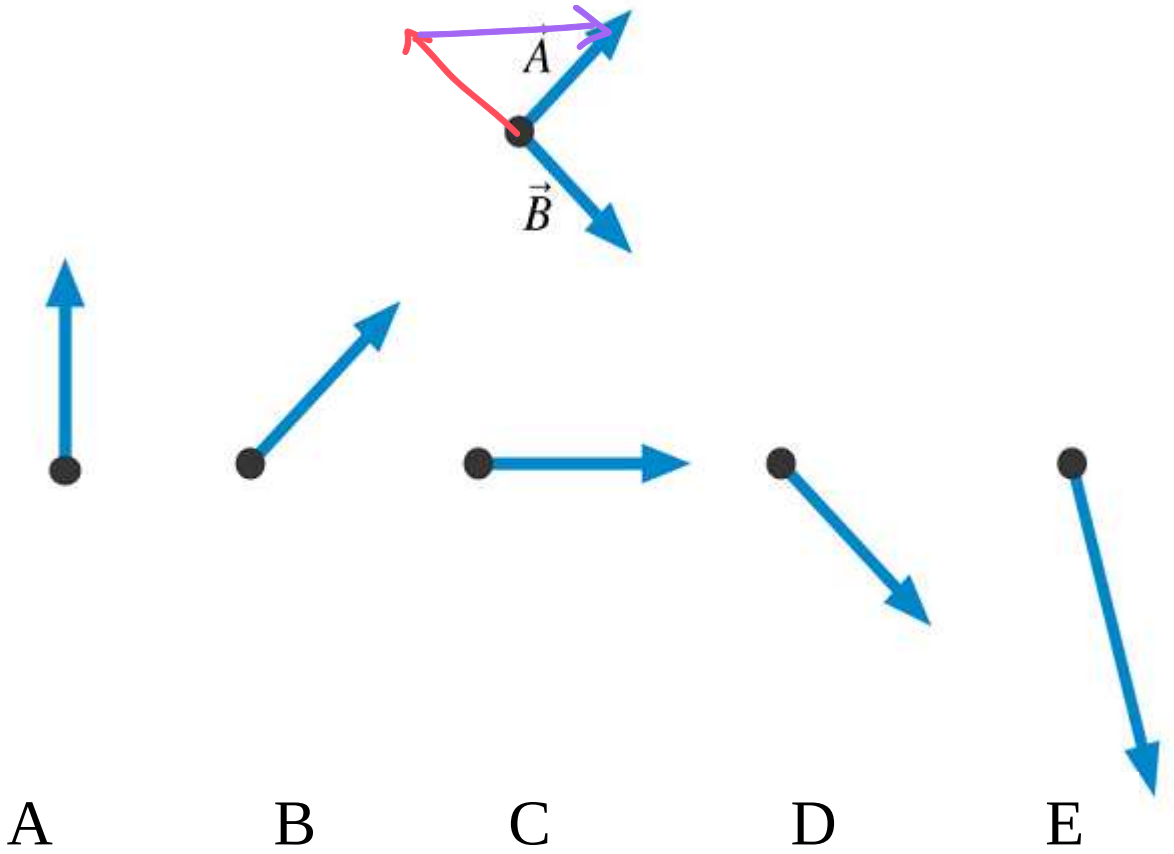
$$\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$

Which figure shows $\vec{A}+\vec{B}$?

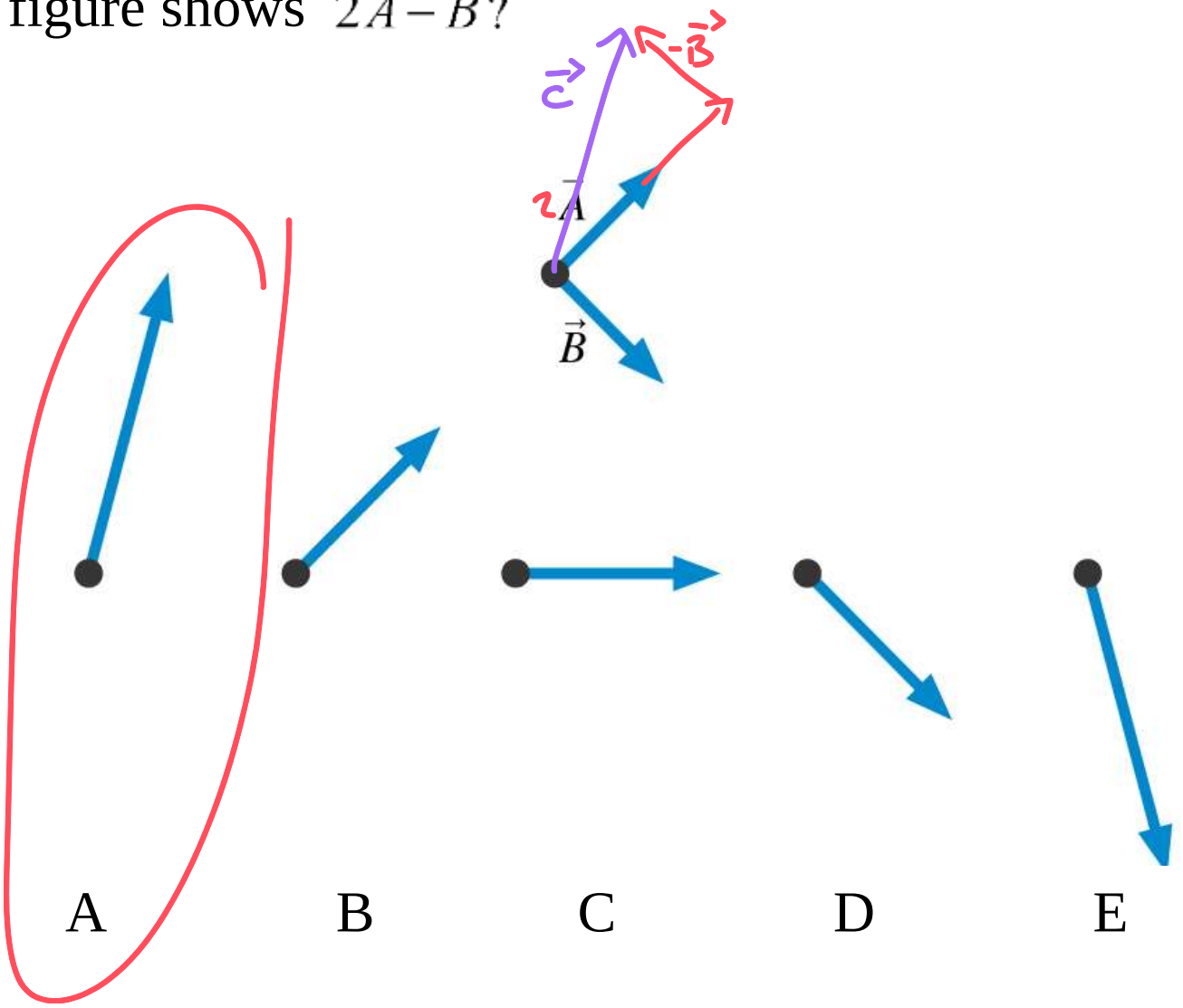


A B C D E

Which figure shows $\vec{A} - \vec{B}$?



Which figure shows $2\vec{A} - \vec{B}$?



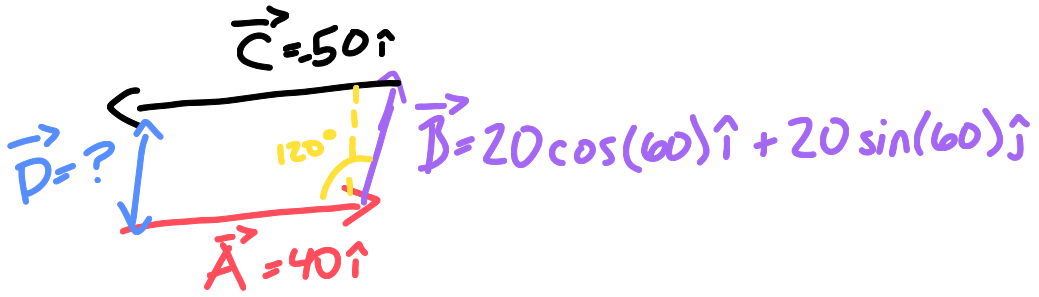
Ex: A cross country SUV moves at 60 km/hr (=1 km/min) on open field. It moves through the following paths:

(1) East for 40 min (A=40 km)

(2) 30^0 East of North for 20 min (B=20 km)

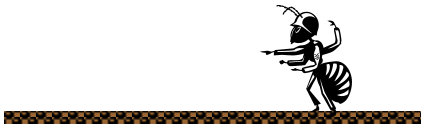
(3) West for 50 min (C=50 km)

Where is the car relative to where it started?



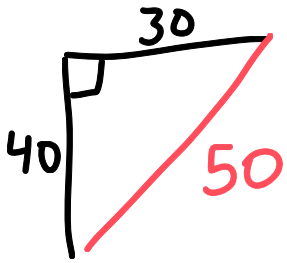
$$\vec{D}=(40+20\cos(60)-50)\hat{\imath}+20\sin(60)\hat{\jmath}$$

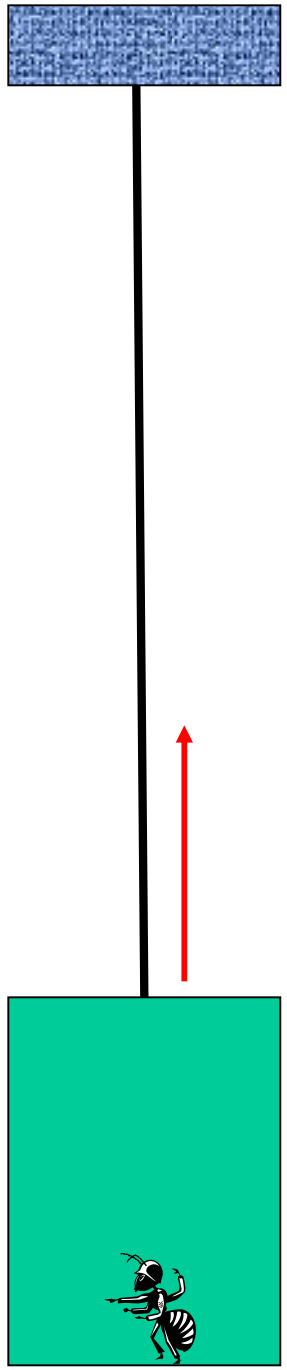
Mr. Ant, standing in an elevator, moves up 40 m with the elevator. He then gets out of the elevator and walks straight for 3 minutes at a speed 10 meters/minute. What is the magnitude of Mr. Ant's net displacement?

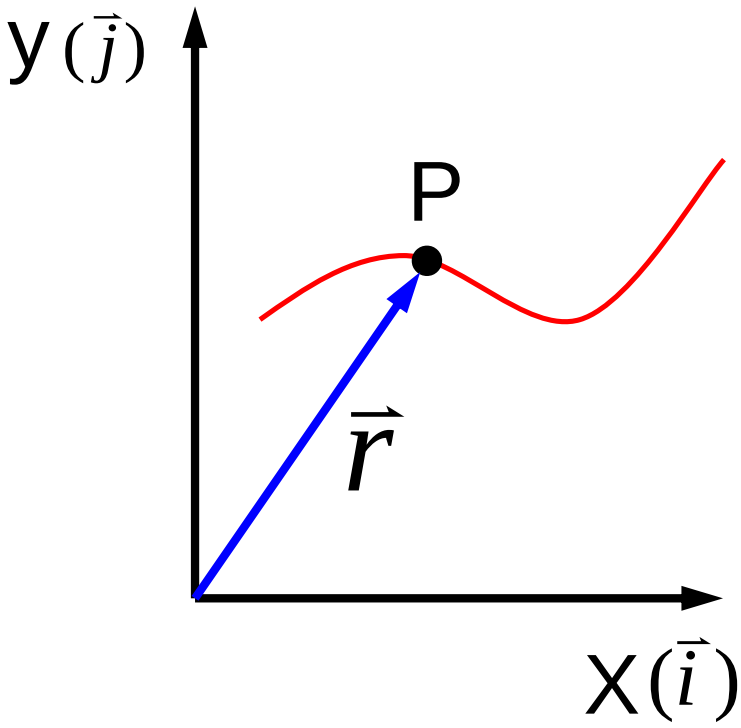


1. 0 m
2. 30 m
3. 40 m
4. 50 m
5. 70m
6. Not enough information given

$40\hat{\imath} + 30\hat{\jmath}$





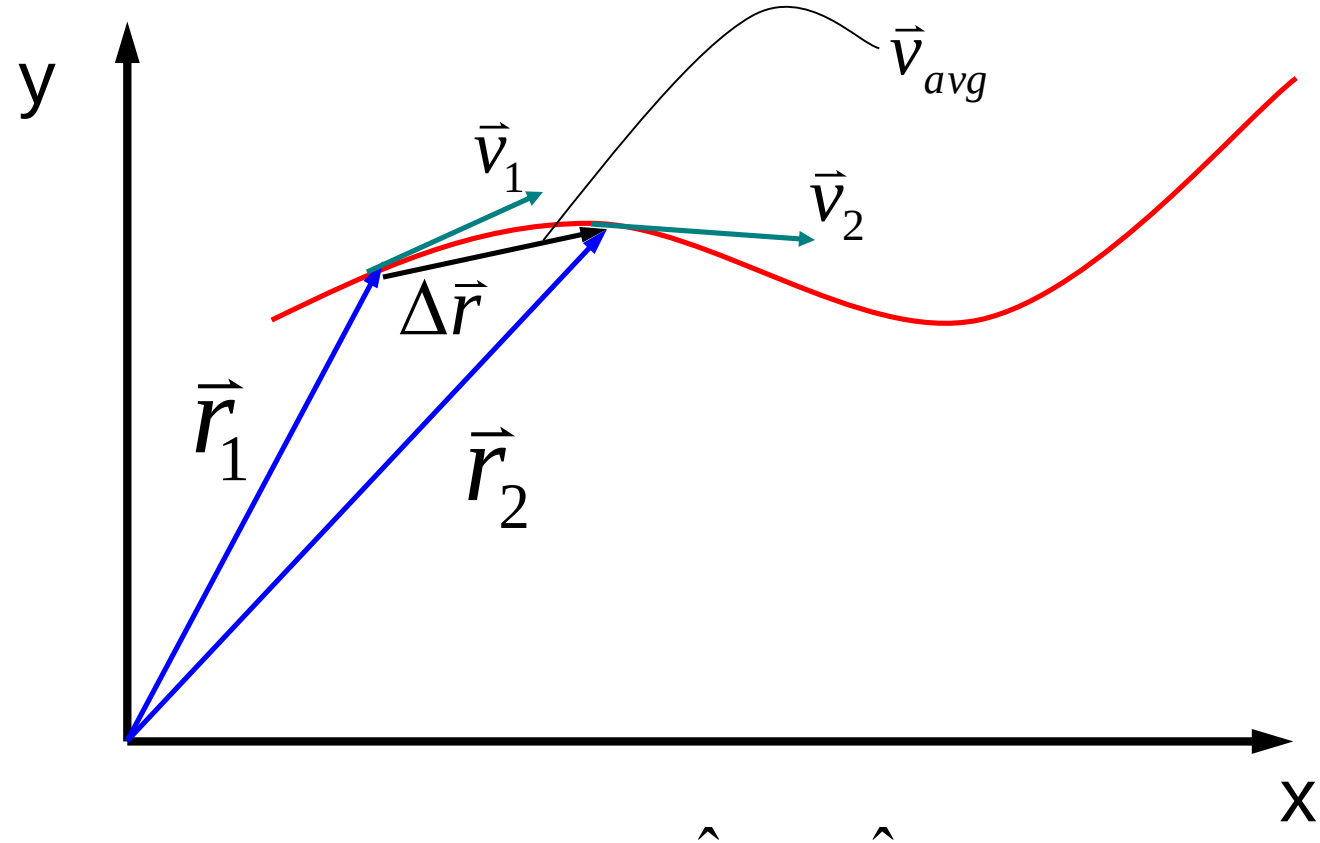


$$\vec{r} = \vec{r}(t) = x(t)\hat{i} + y(t)\,\hat{j}$$

$$\vec{V} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\,\hat{j} = V_x\hat{i} + V_y\,\hat{j}$$

$$\vec{a} = \frac{d^2\vec{r}}{dt^2} = \frac{d\vec{V}}{dt} = \frac{d^2x}{dt^2}\hat{i} + \frac{d^2y}{dt^2}\,\hat{j}$$

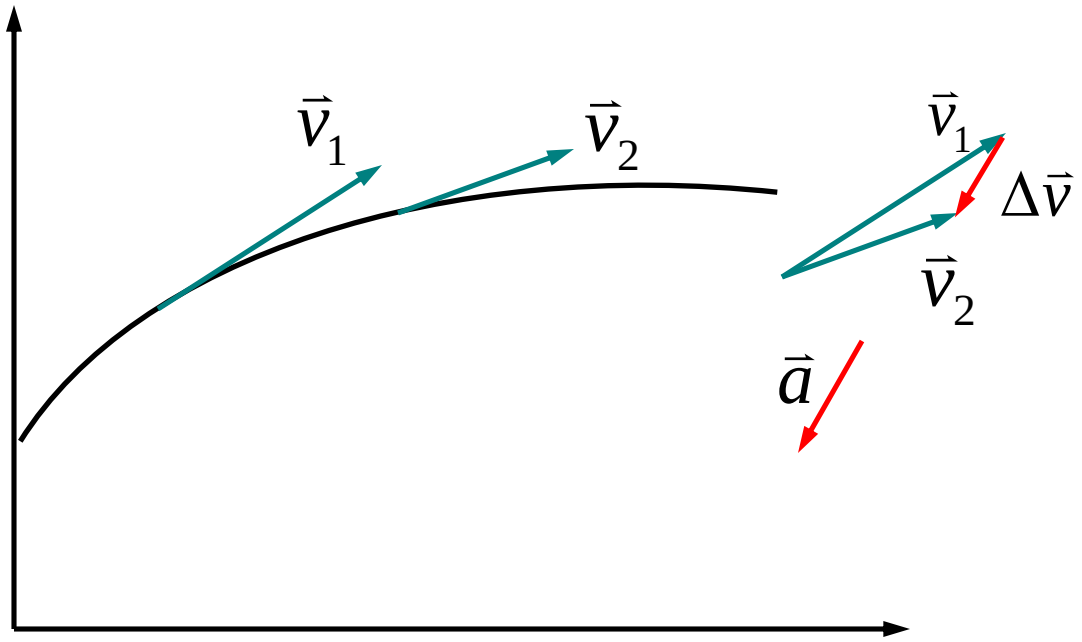
$$= \frac{dV_x}{dt}\hat{i} + \frac{dV_y}{dt}\,\hat{j} = a_x\hat{i} + a_y\,\hat{j}$$



$$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1 = \Delta x\hat{i} + \Delta y\hat{j}$$

$$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} = \frac{\Delta x}{\Delta t}\hat{i} + \frac{\Delta y}{\Delta t}\hat{j}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} = v_x\hat{i} + v_y\hat{j}$$



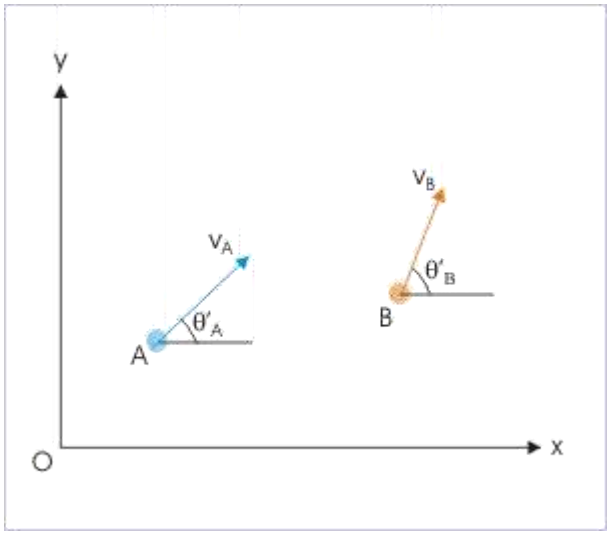
$$\Delta\vec{v} = \vec{v}_2 - \vec{v}_1$$

$$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t}$$

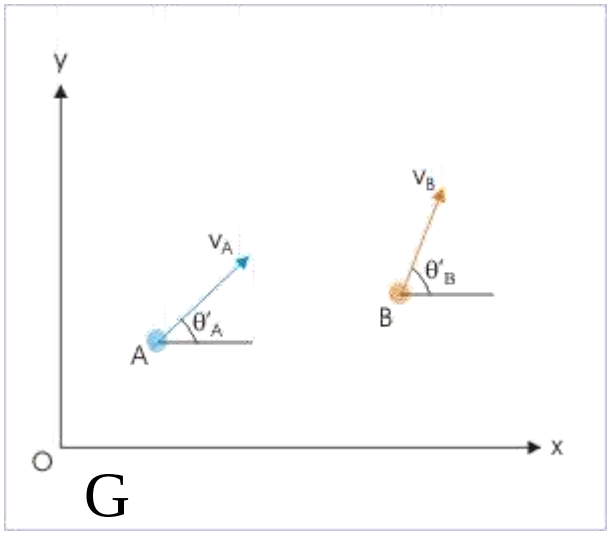
$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{dv_x}{dt}\hat{i} + \frac{dv_y}{dt}\hat{j} = a_x\hat{i} + a_y\hat{j}$$

Relative Motion

What is V of A relative to B?



Relative Motion

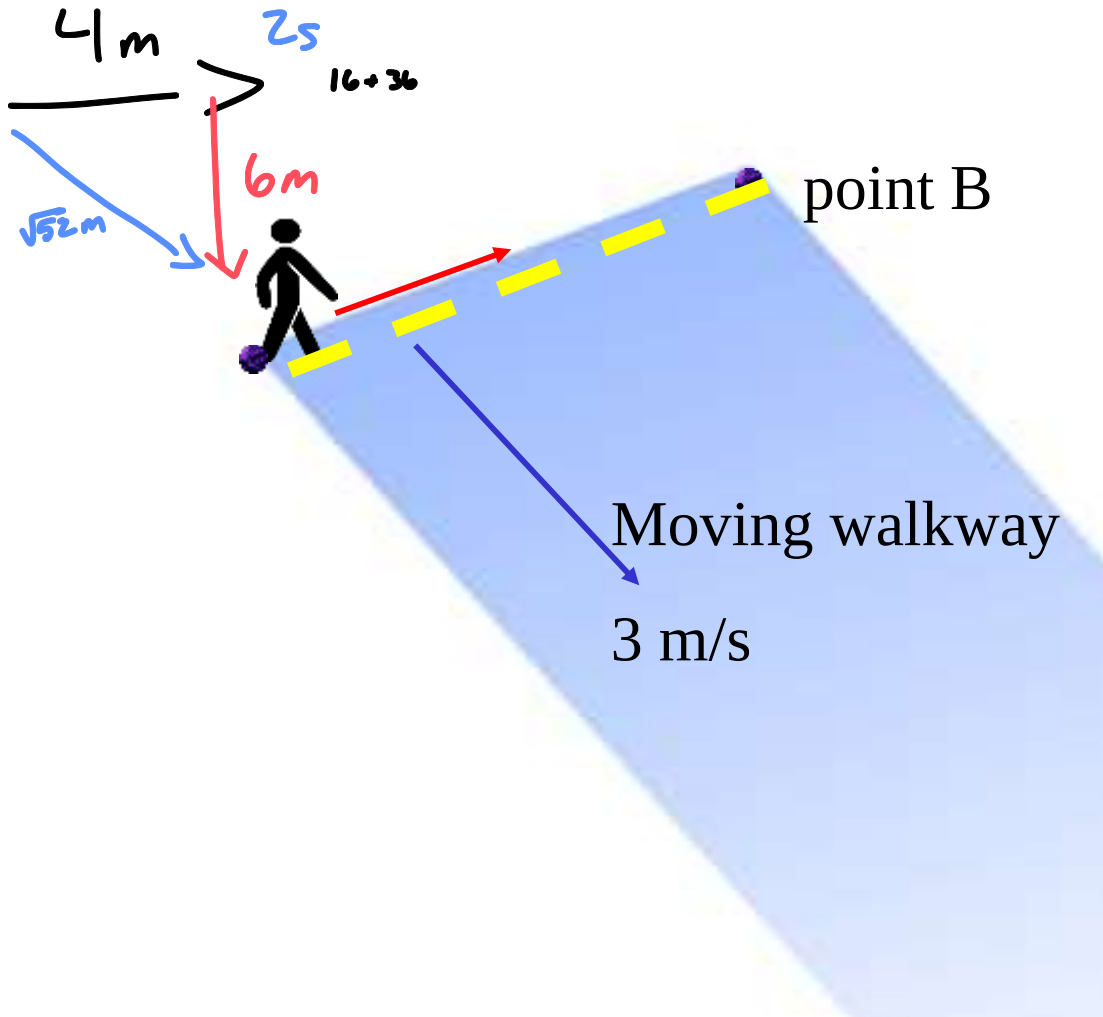


What is V of A relative to B?

$$\vec{V}_{AB} = \vec{V}_{AG} - \vec{V}_{BG} = \left(V_{AGx} - V_{BGx}\right)\hat{i} + \left(V_{AGy} - V_{BGy}\right)\hat{j}$$

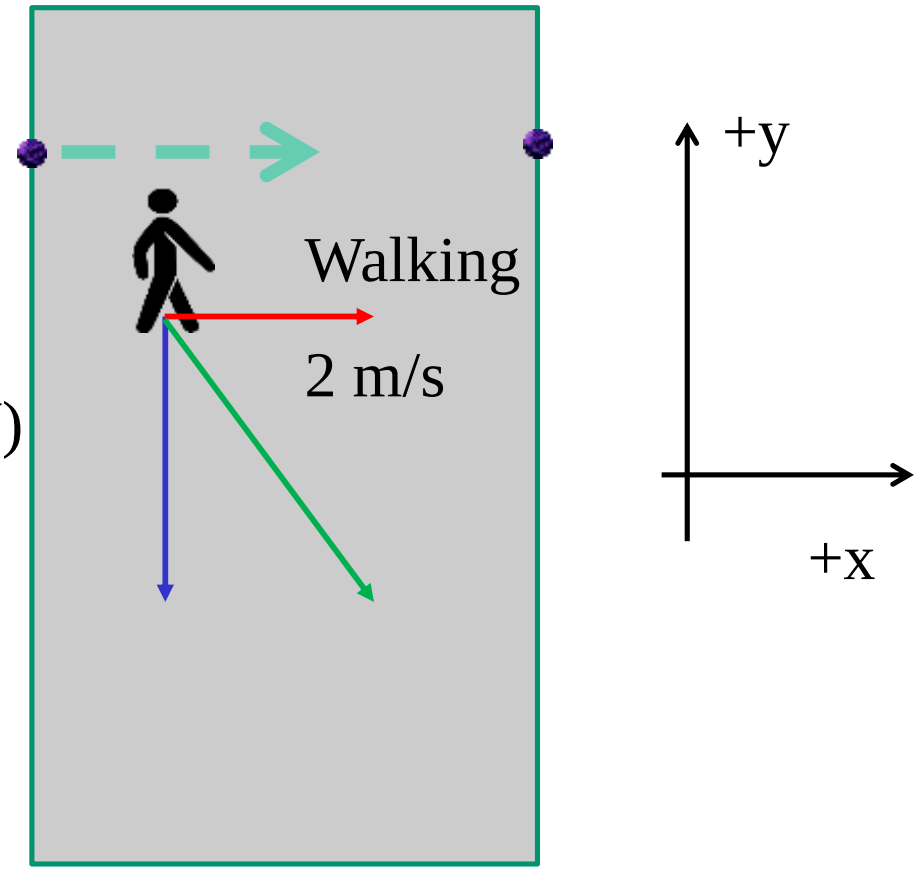
Mr. Q starts to walk along the dotted line painted on the moving walkway. The width of the walkway is 4 m, and it is moving in the direction shown at 3 m/s. If Mr. Q's walking speed is 2 m/s, how far away will he be ***from point B*** when he reaches the other side?

1. 12 m
2. 7 m
3. 6 m
4. 5 m
5. 4 m
6. 3 m
7. 1 m
8. None of the Above



Relative Motion

What is V of the person (P) relative to ground (G)?



$$\vec{V}_{PG} = \vec{V}_{PW} + \vec{V}_{WG} = \left(V_{PWx} + V_{WGx}\right)\hat{i} + \left(V_{PWy} + V_{WGy}\right)\hat{j}$$

$$= \left(2 + 0\right)\hat{i} + \left(0 + (-3)\right)\hat{j} = 2\hat{i} - 3\hat{j}$$