Fun Physics Fact of the Day

1,000

Number of stars known in ancient times

2,000

Number of stars known in 1600 A.D.

3,000

Number of stars known in 1712 A.D.

The machinery of the heavens is… like a clock… all the variety of motions is from one simple force… as in the clock all motions are from a simple weight.”

Johannes Kepler

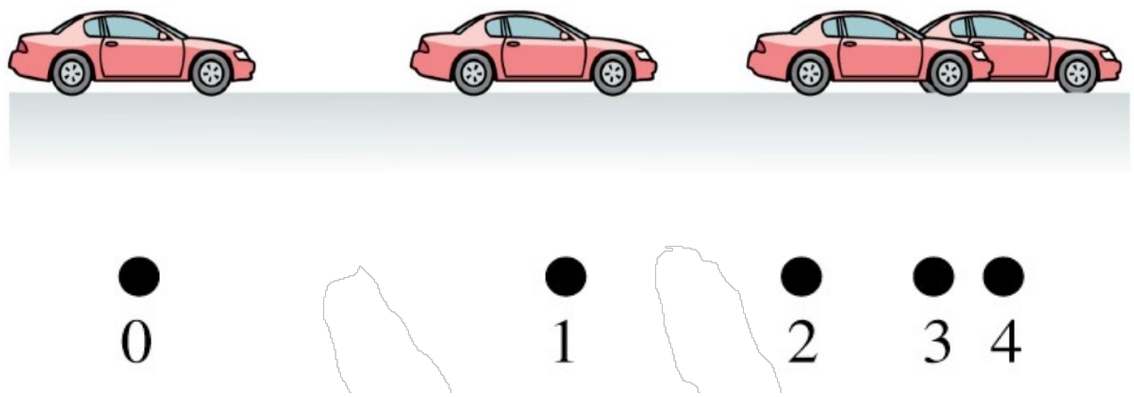
225,300

Number of stars known in 1918 A.D.

16 million

Number of stars known in 1983

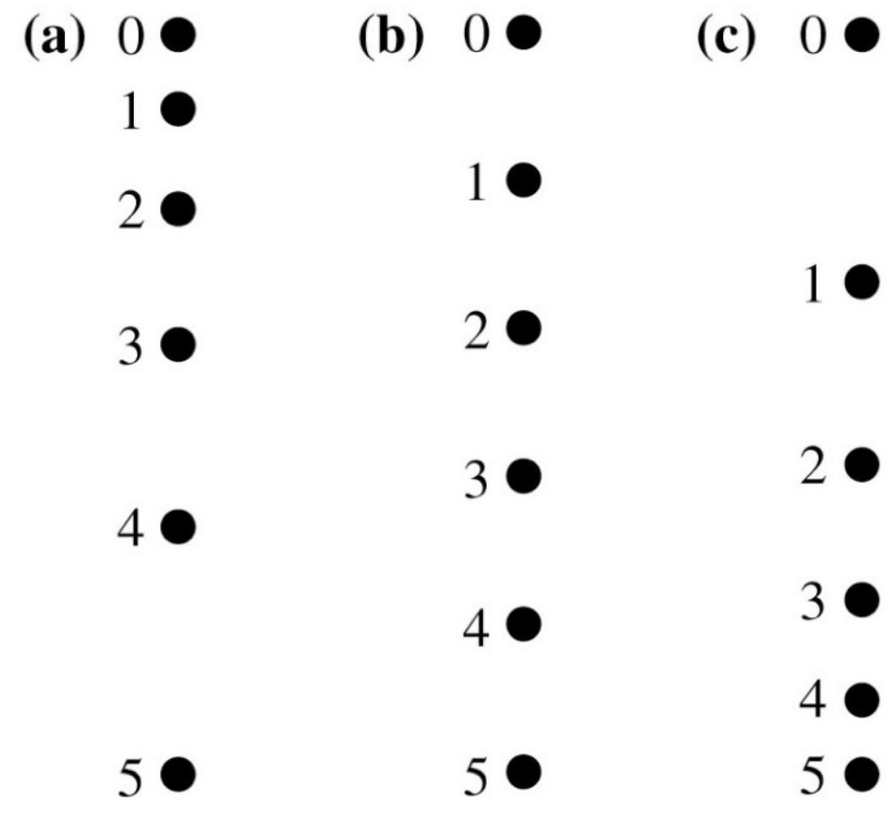
Motion Diagrams



Question #1

Three motion diagrams are shown. Which is a dust particle settling to the floor at constant speed, which is a ball dropped from the roof of a building, and which is a descending rocket slowing to make a soft landing on Mars?

A. (a) is dust, (b) is ball, (c) is rocket.
B. (a) is rocket, (b) is dust, (c) is ball.
C. (a) is rocket, (b) is ball, (c) is dust.
D. (a) is ball, (b) is dust, (c) is rocket.
E. (a) is ball, (b) is rocket, (c) is dust.



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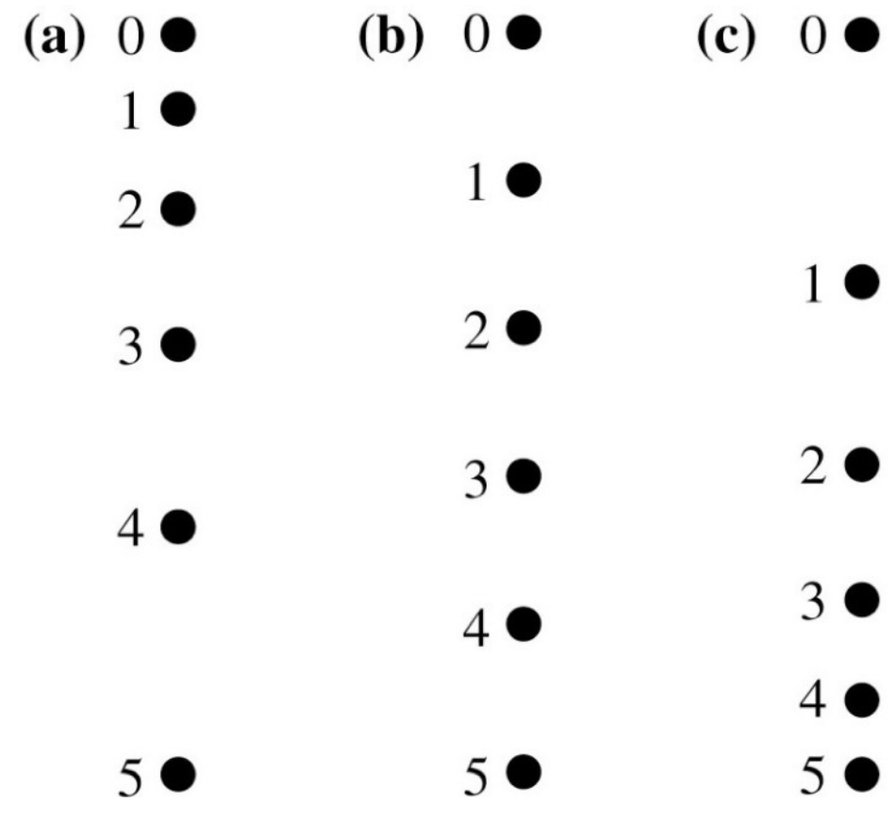


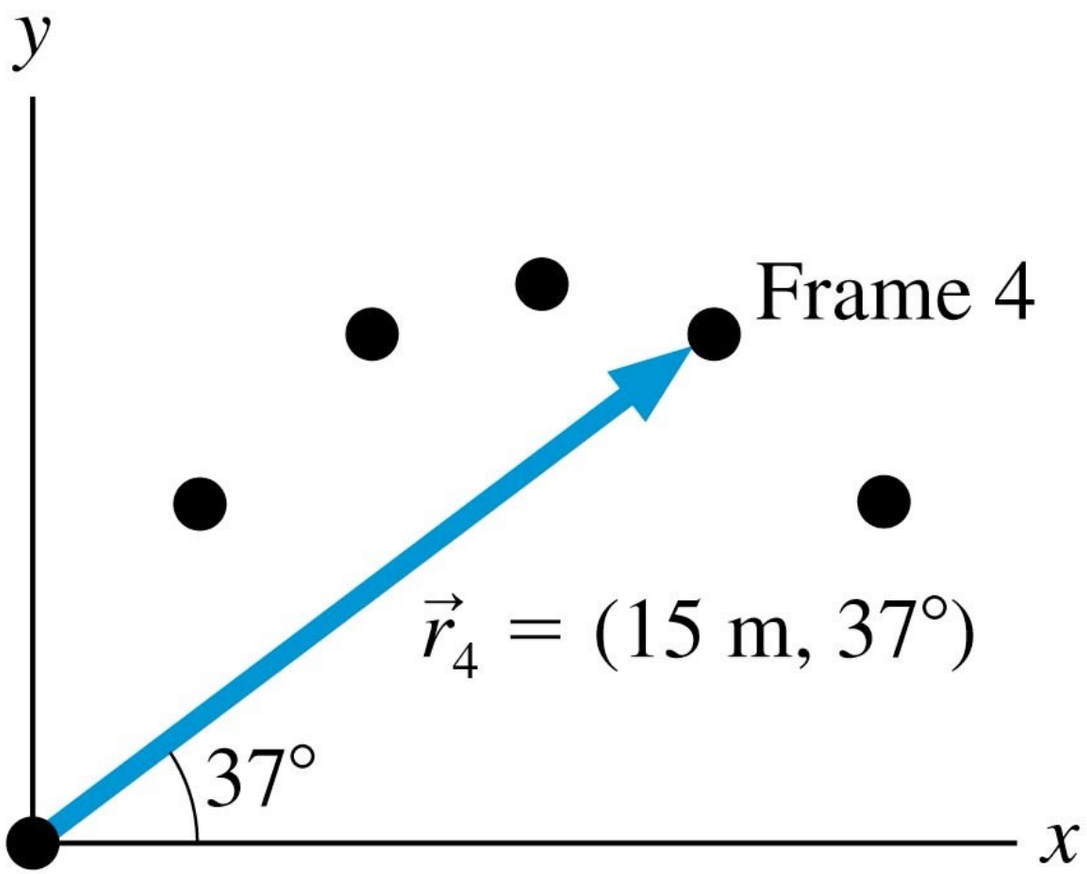
Position Vector

Vector

Magnitude and Direction

Scalar

Magnitude only



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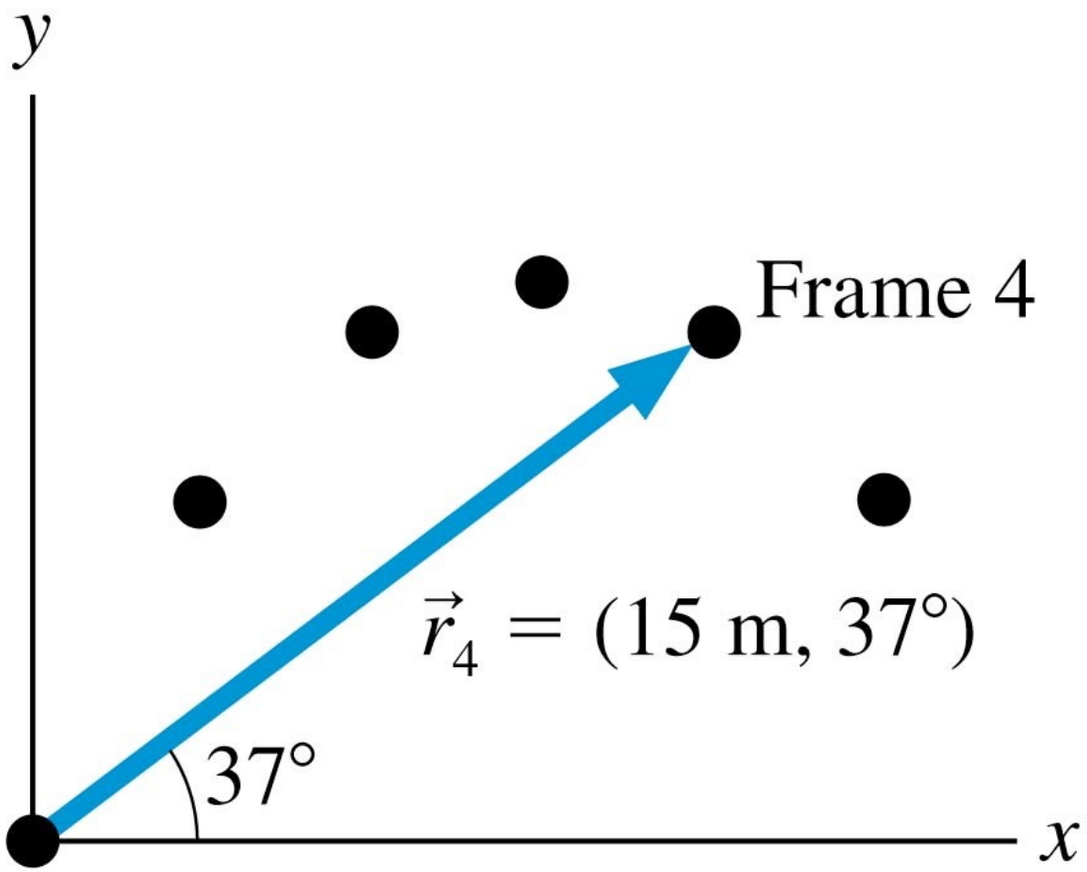


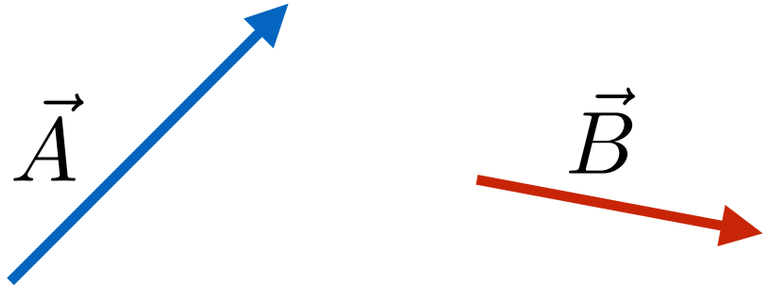
Mass

Volume

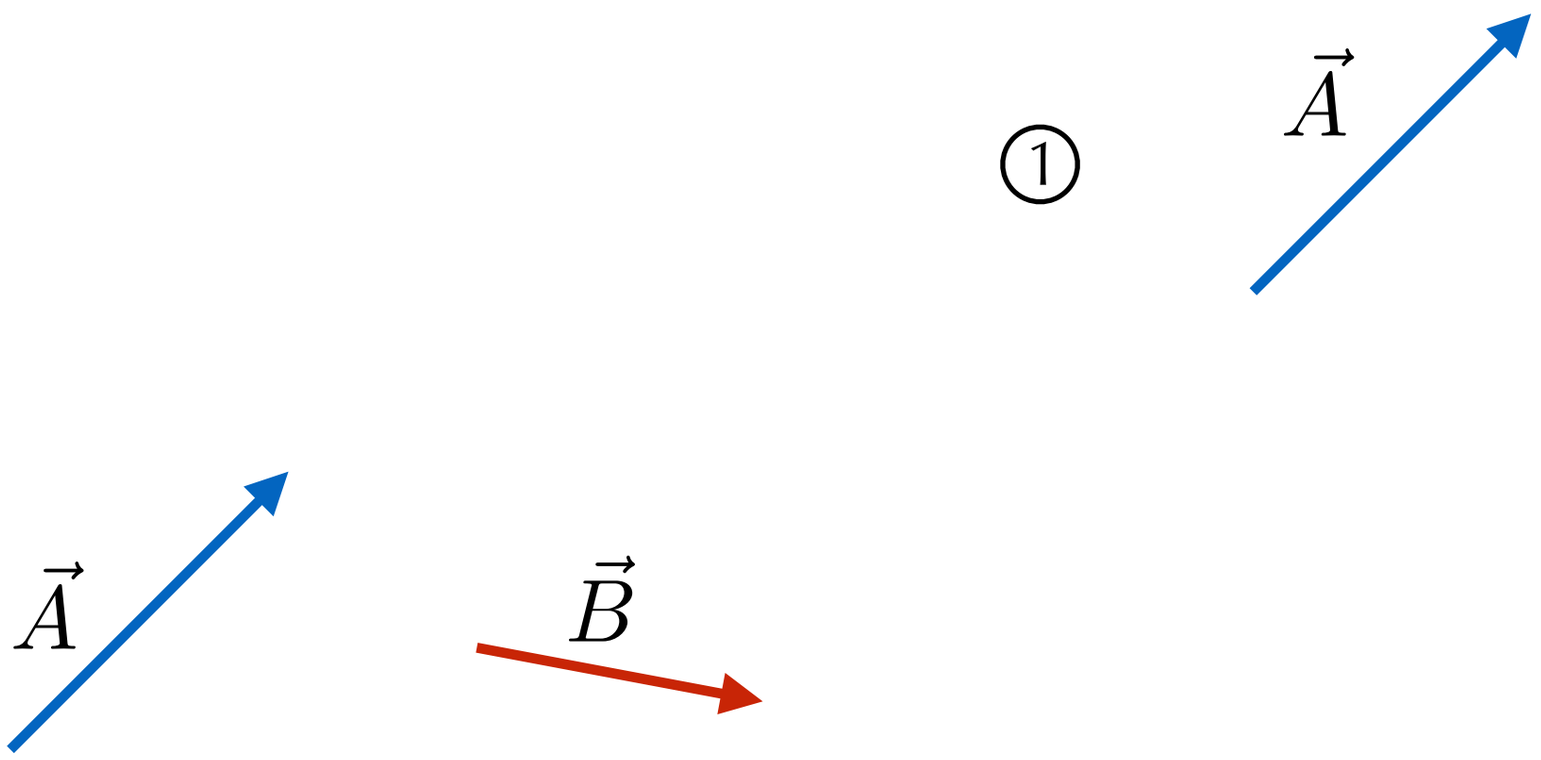
Length

Speed

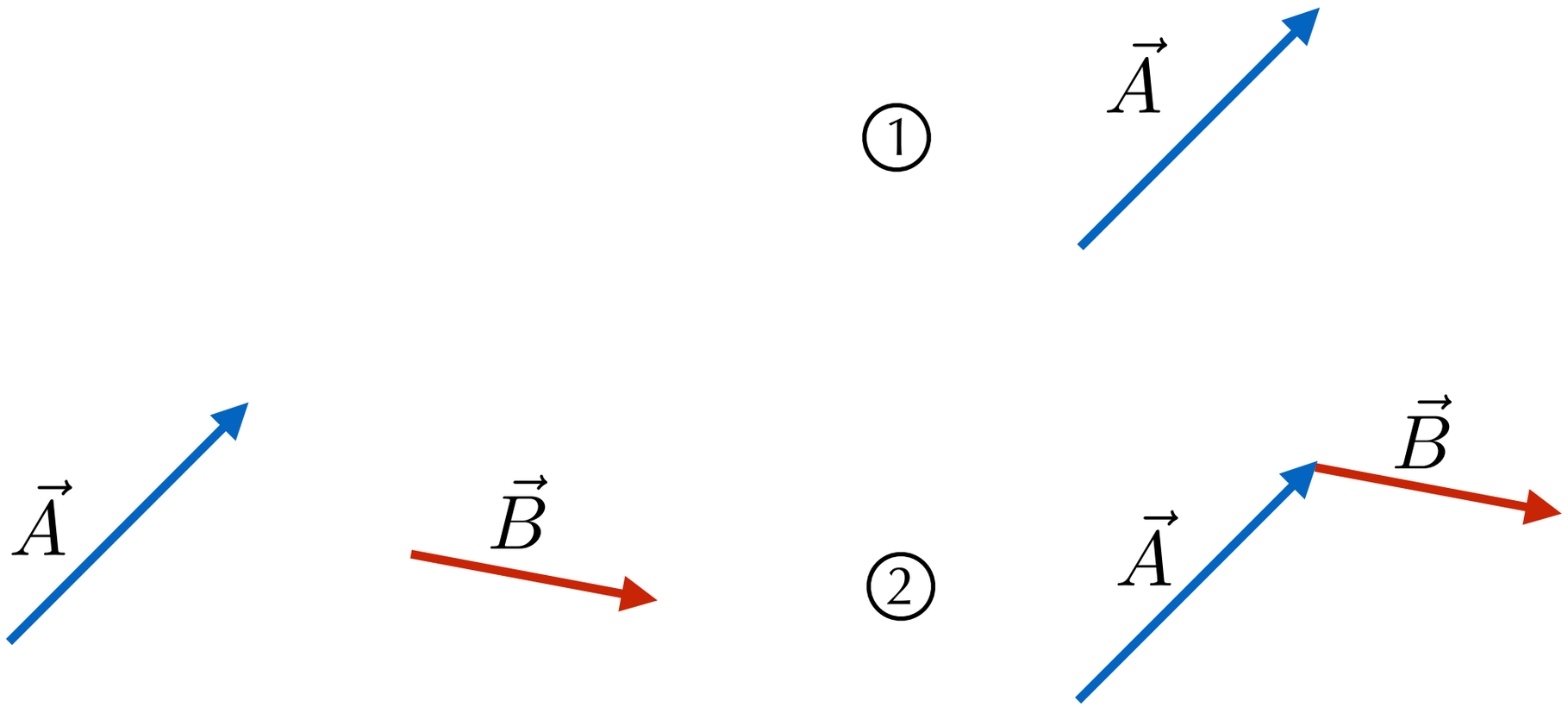
Vector Addition



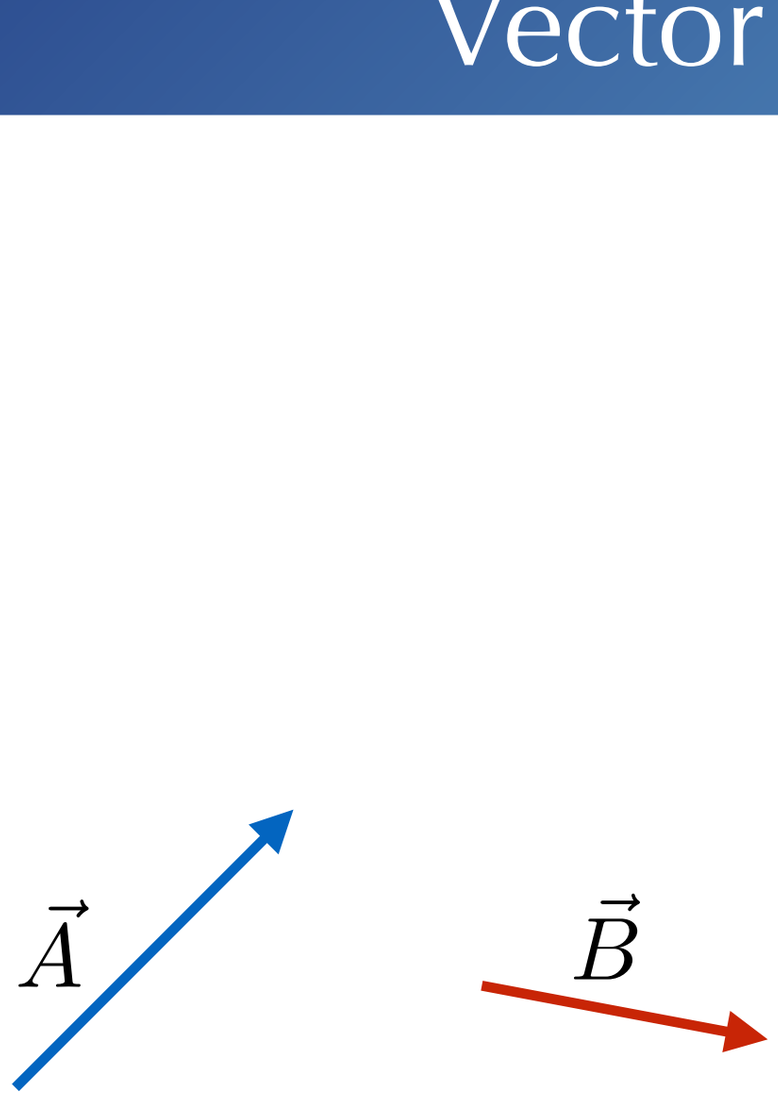
Vector Addition



Vector Addition



Vector Addition

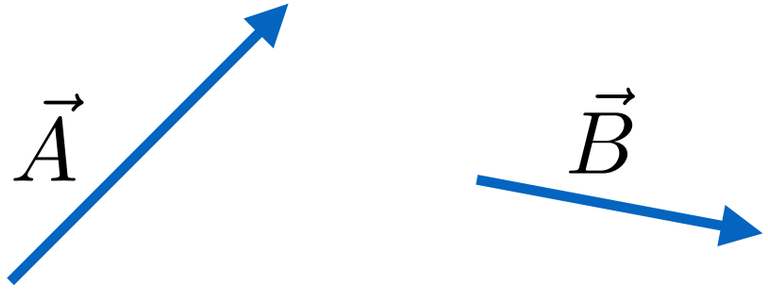


① $\vec{A}$

② $\vec{A}$ $\vec{B}$

③ $\vec{A}$ $\vec{B}$ $\vec{A}+\vec{B}$

Vector Subtraction



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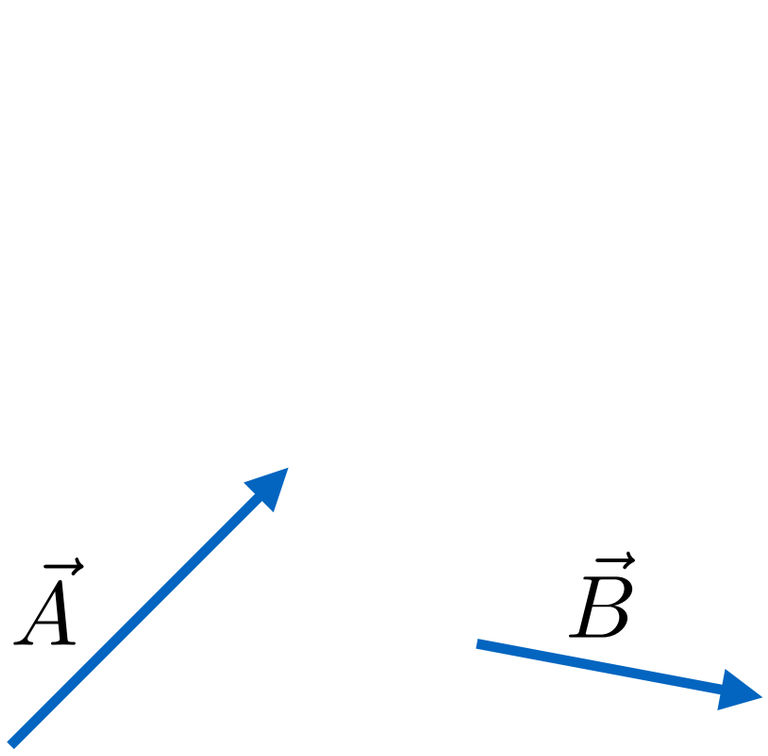
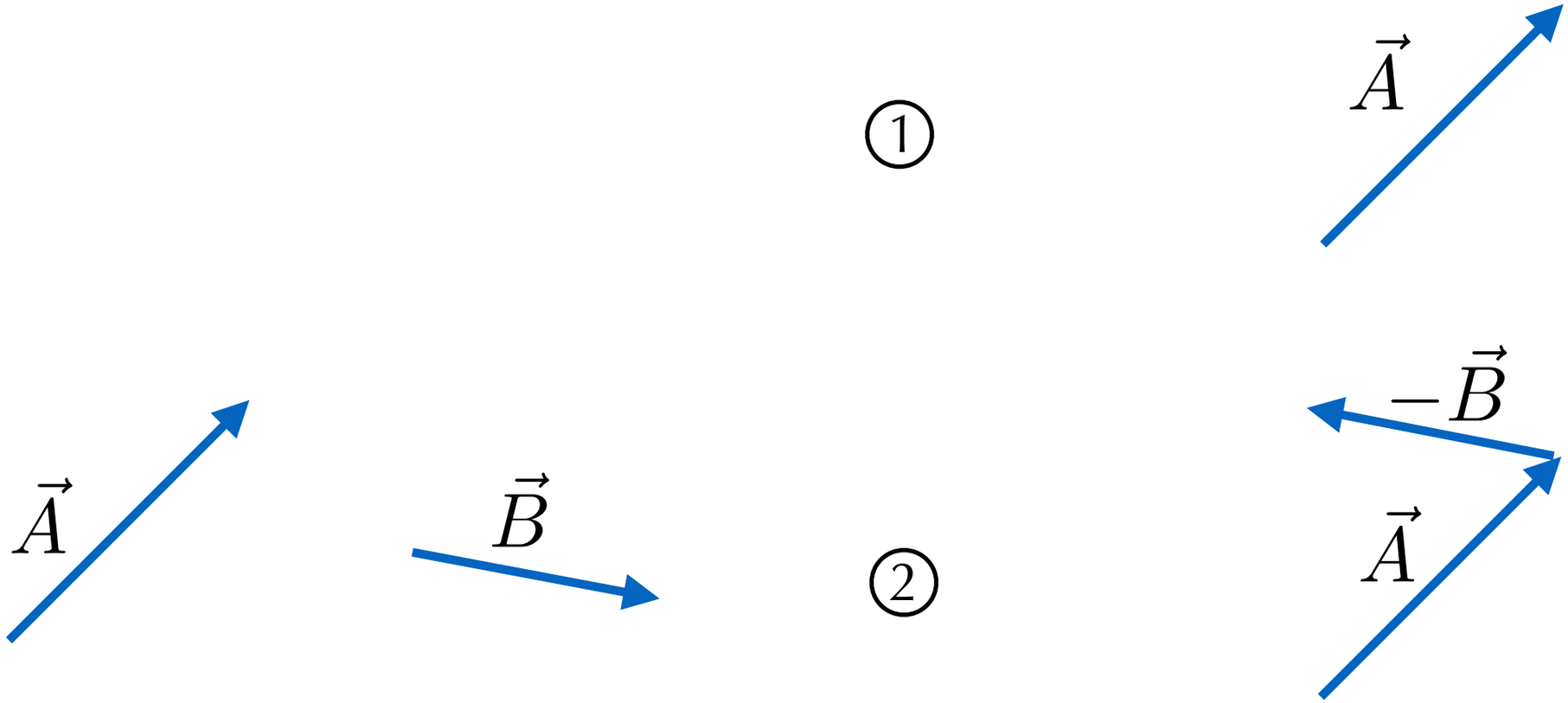


Vector Subtraction



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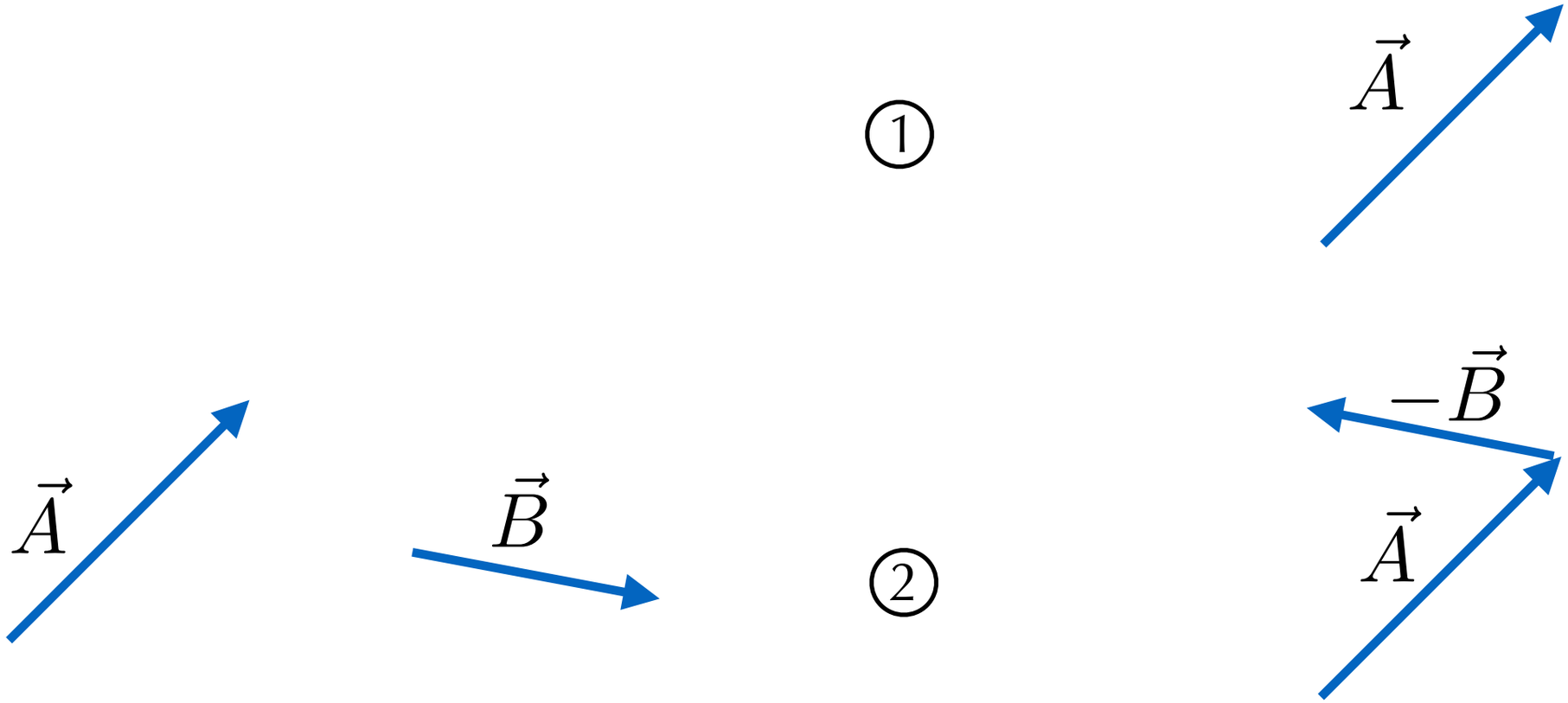
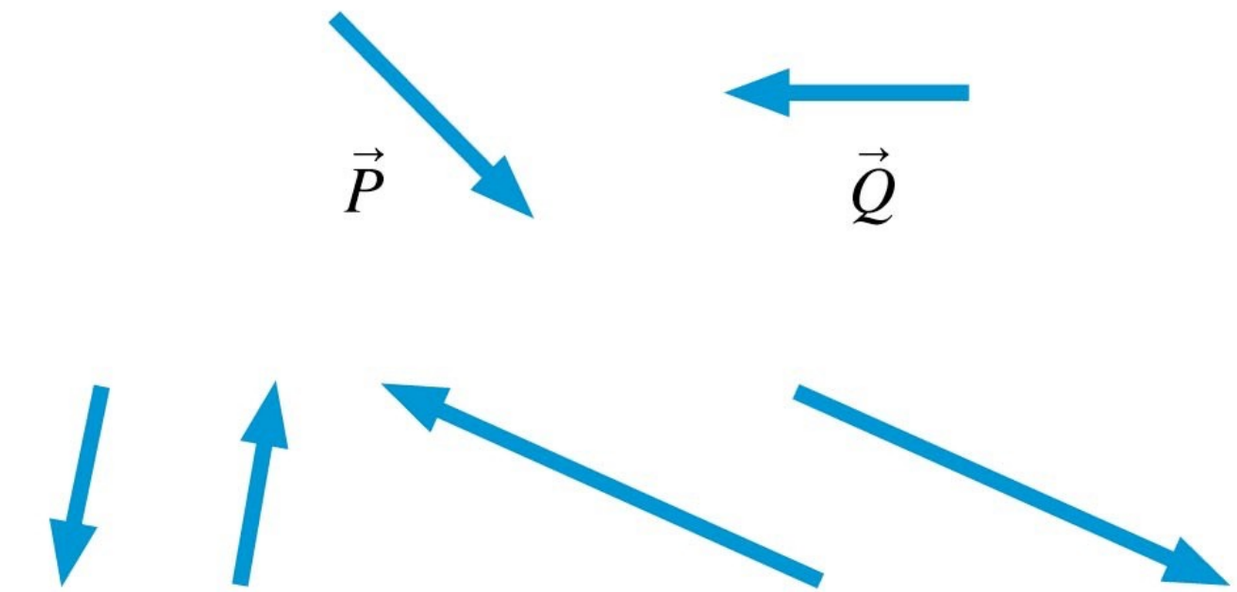


Question #2

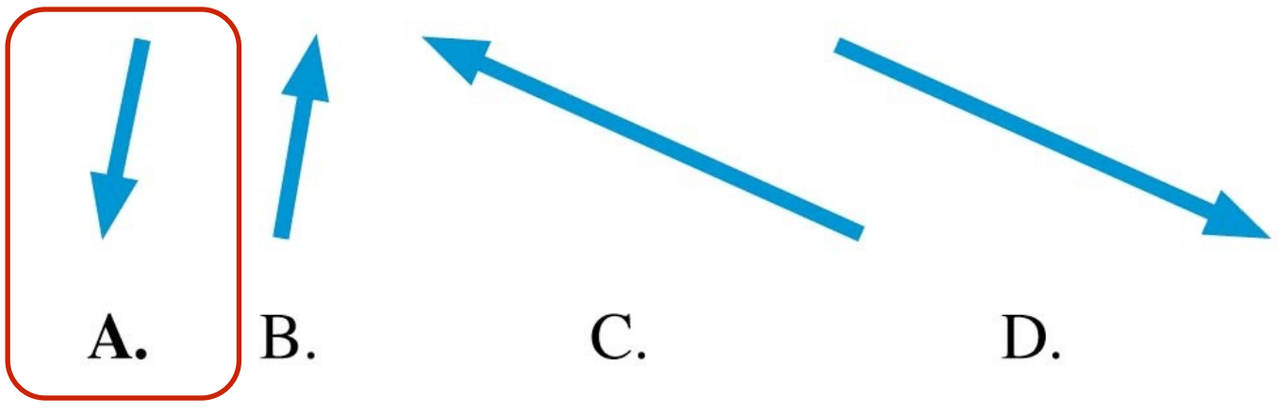
Given the vectors $\vec{P}$ and $\vec{Q}$, what is $\vec{P} + \vec{Q}$

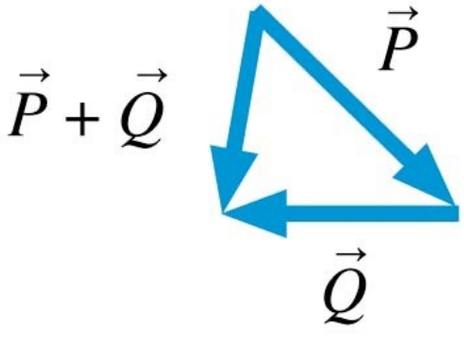


B E D C

Quiz

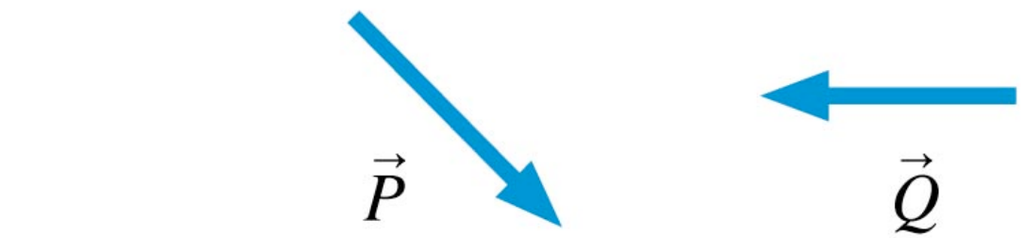
Given the vectors $\vec{P}$ and $\vec{Q}$, what is $\vec{P} + \vec{Q}$





Question #3

Given the vectors $\vec{P}$ and $\vec{Q}$, what is $\vec{P} - \vec{Q}$

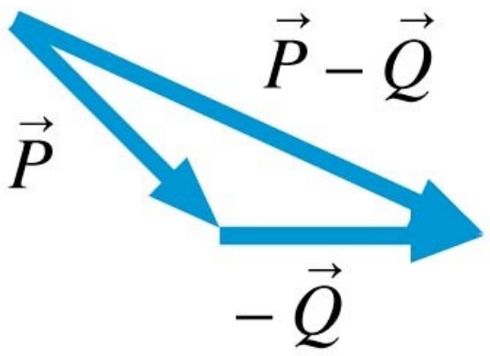


E B A C

Quiz

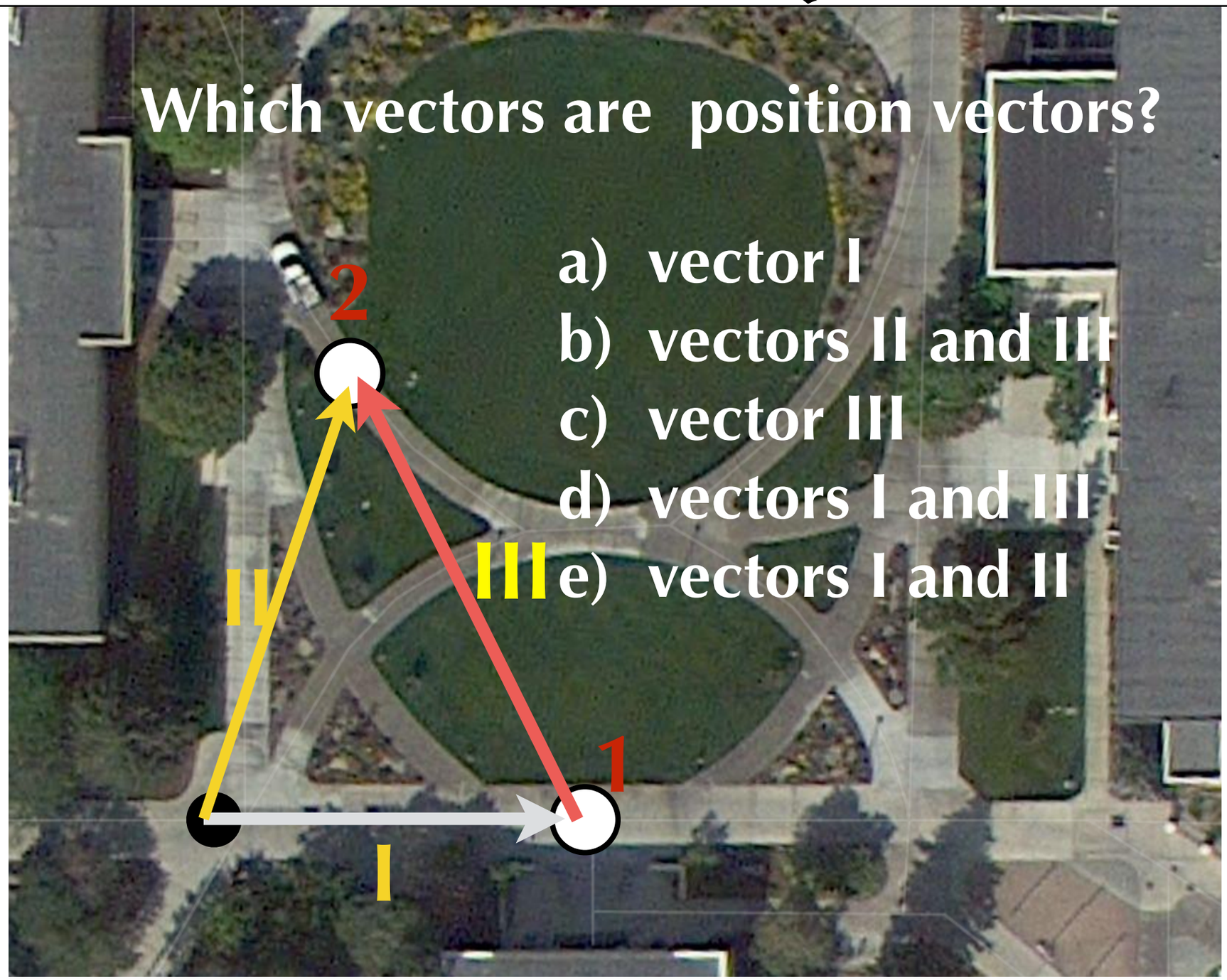
Given the vectors $\vec{P}$ and $\vec{Q}$, what is $\vec{P} - \vec{Q}$

A. B. C. **D.**



You are standing just outside the library (point 1 in the figure) when you notice that you are late for physics class. Several seconds later, after running towards the Romney building, you find yourself at point 2. (The black point has been chosen as the origin of our coordinate system for this problem)

Question #4



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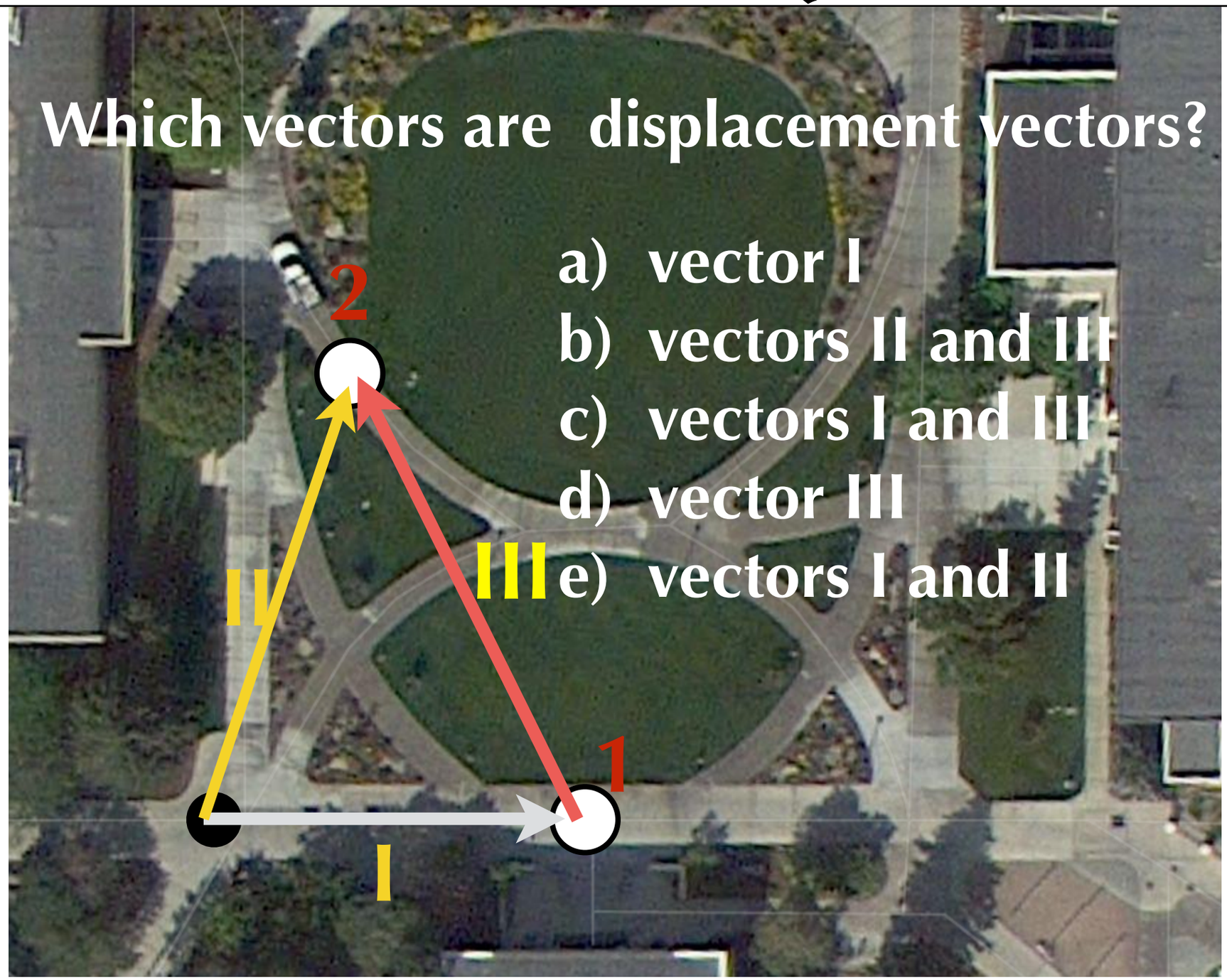

Velocity vs. Speed

Velocity vs. Speed

Average speed

$$v_{\text{avg}} = \frac{\text{distance traveled}}{\text{time elapsed}}$$

Velocity vs. Speed

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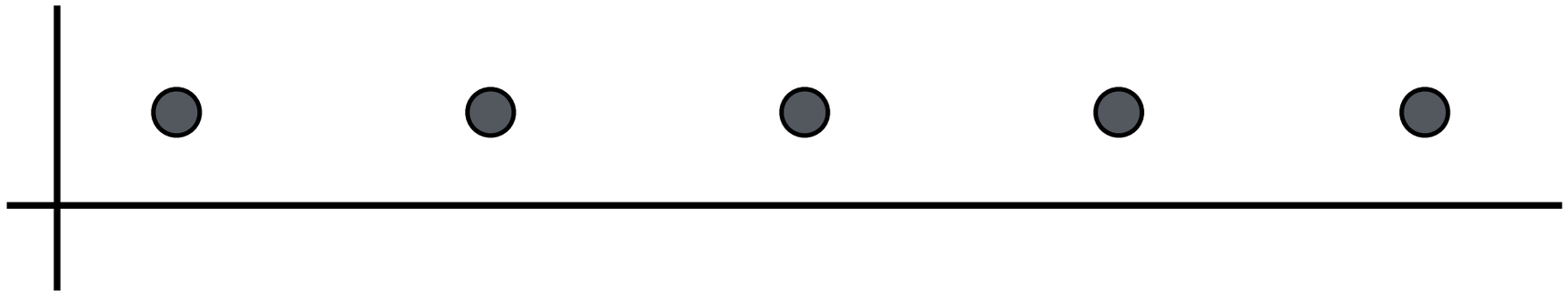
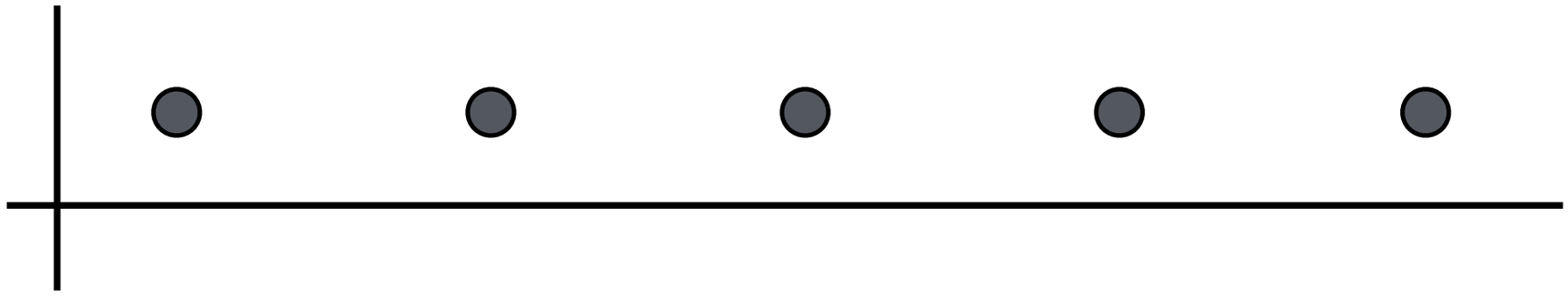
Motion Diagrams with Velocity Vectors

What are the displacement vectors here?



Motion Diagrams with Velocity Vectors

What are the displacement vectors here?



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

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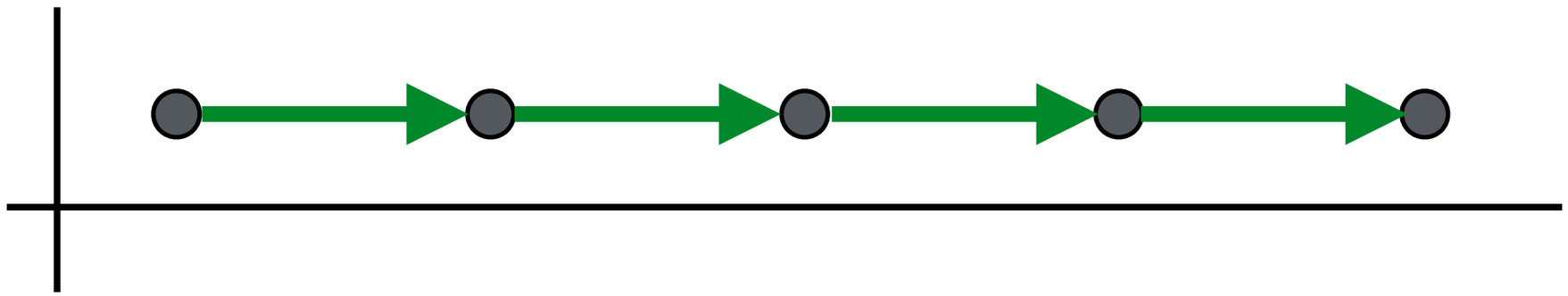

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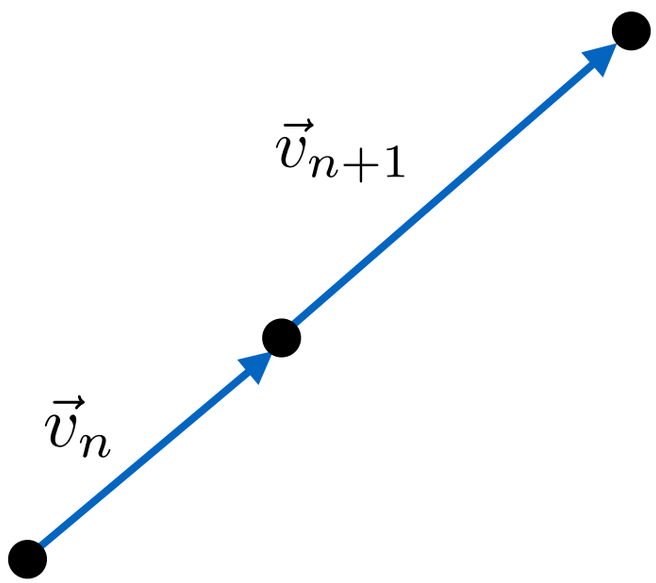
Finding the Acceleration Vector



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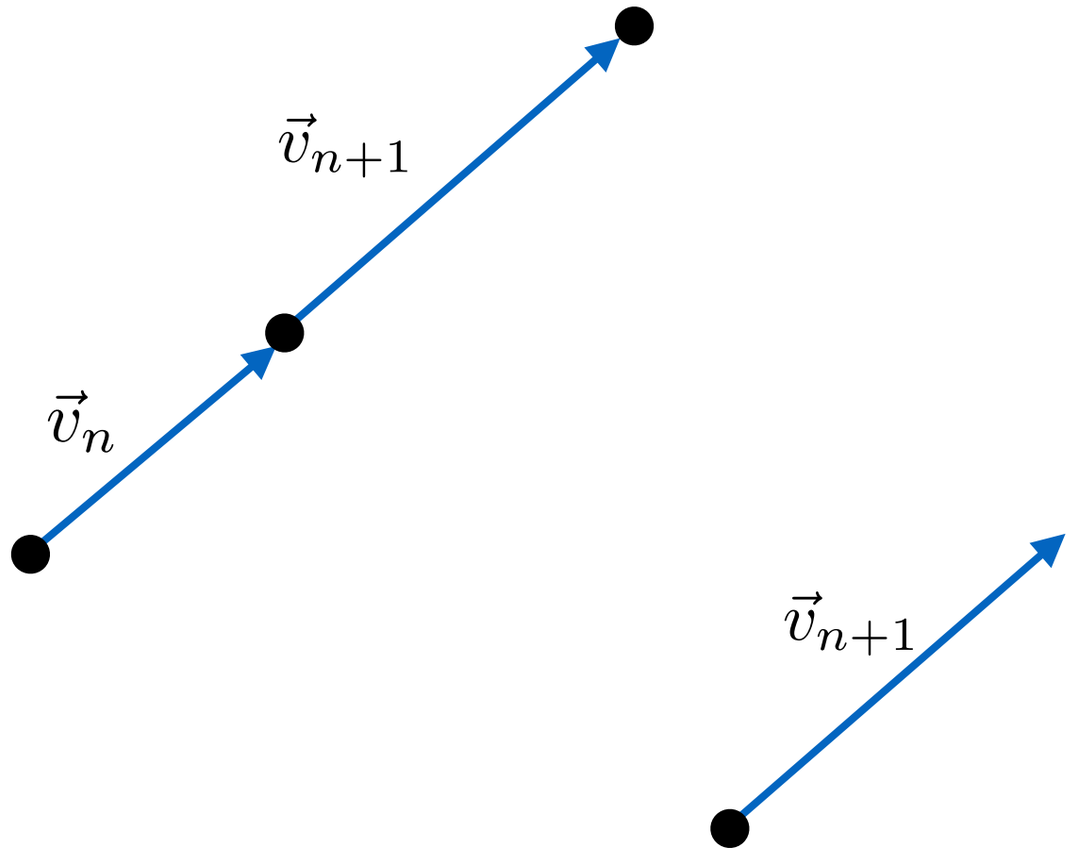

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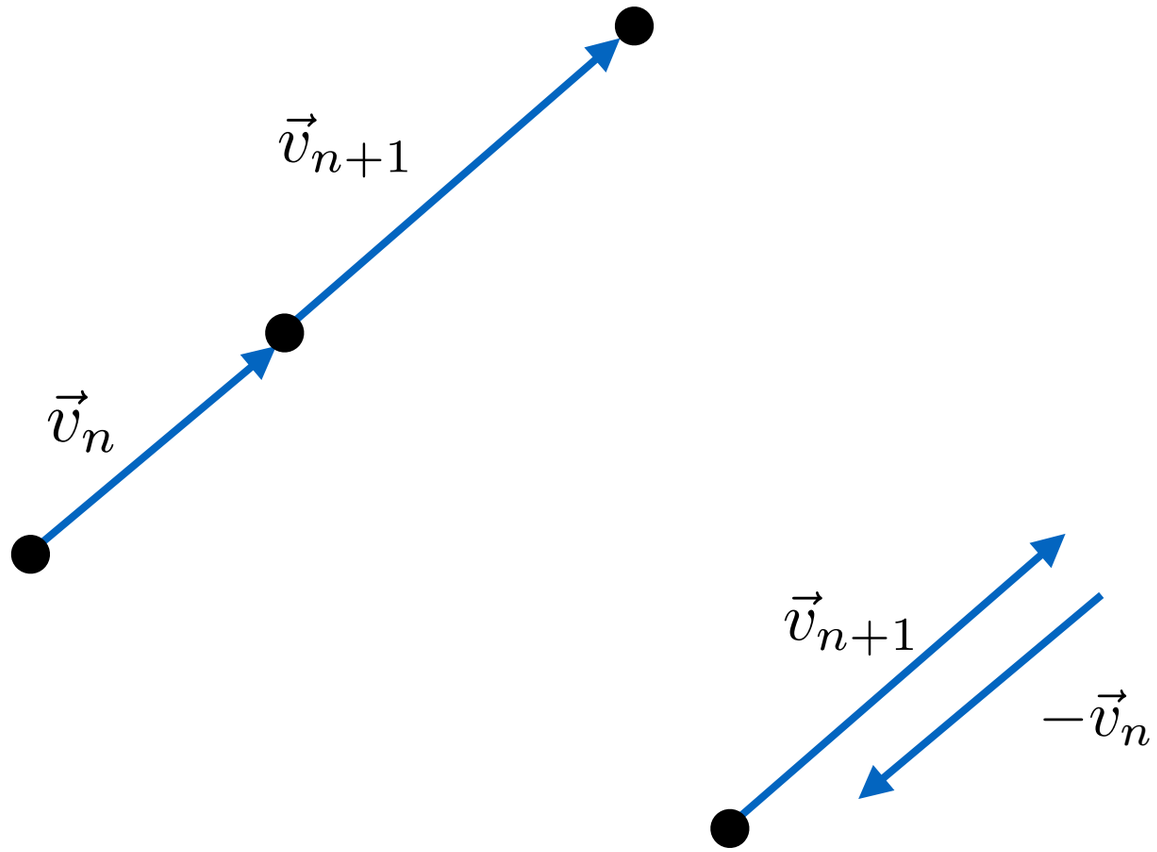

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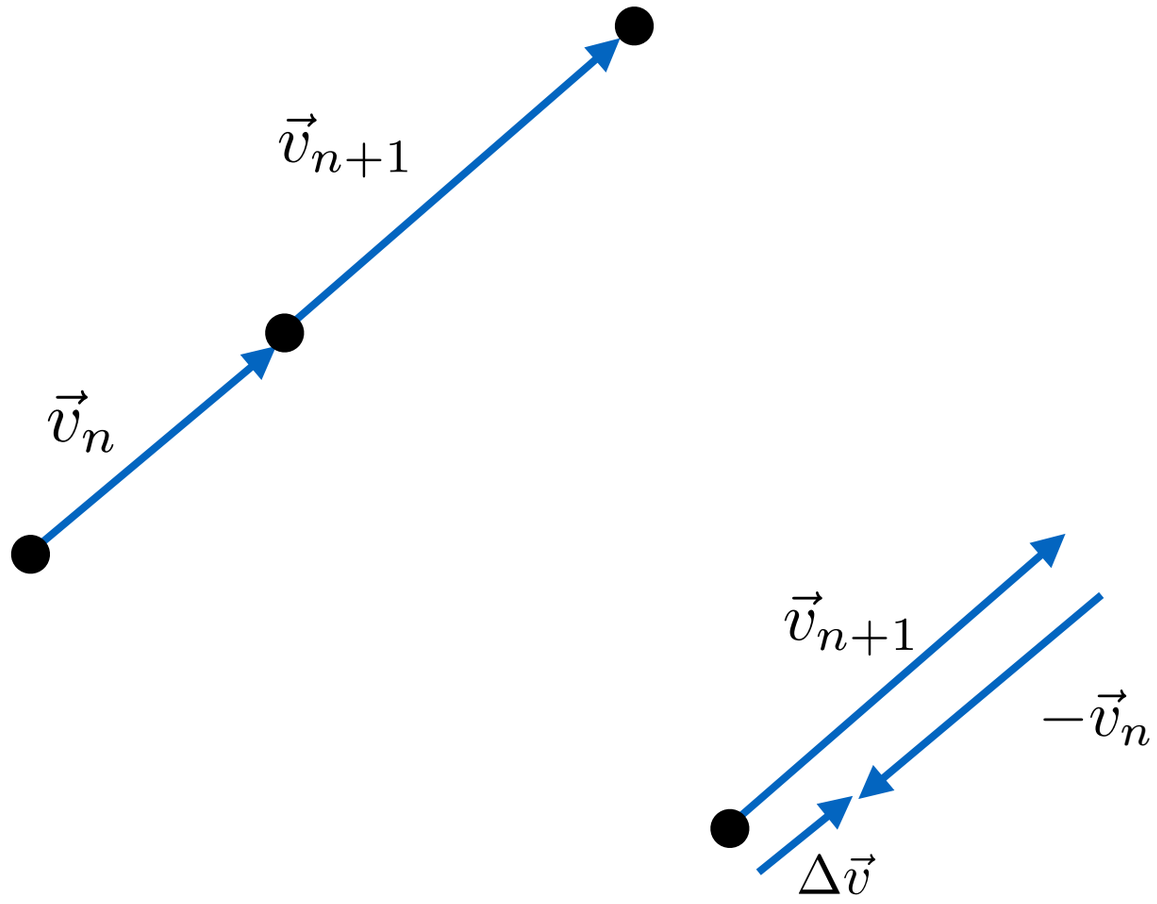

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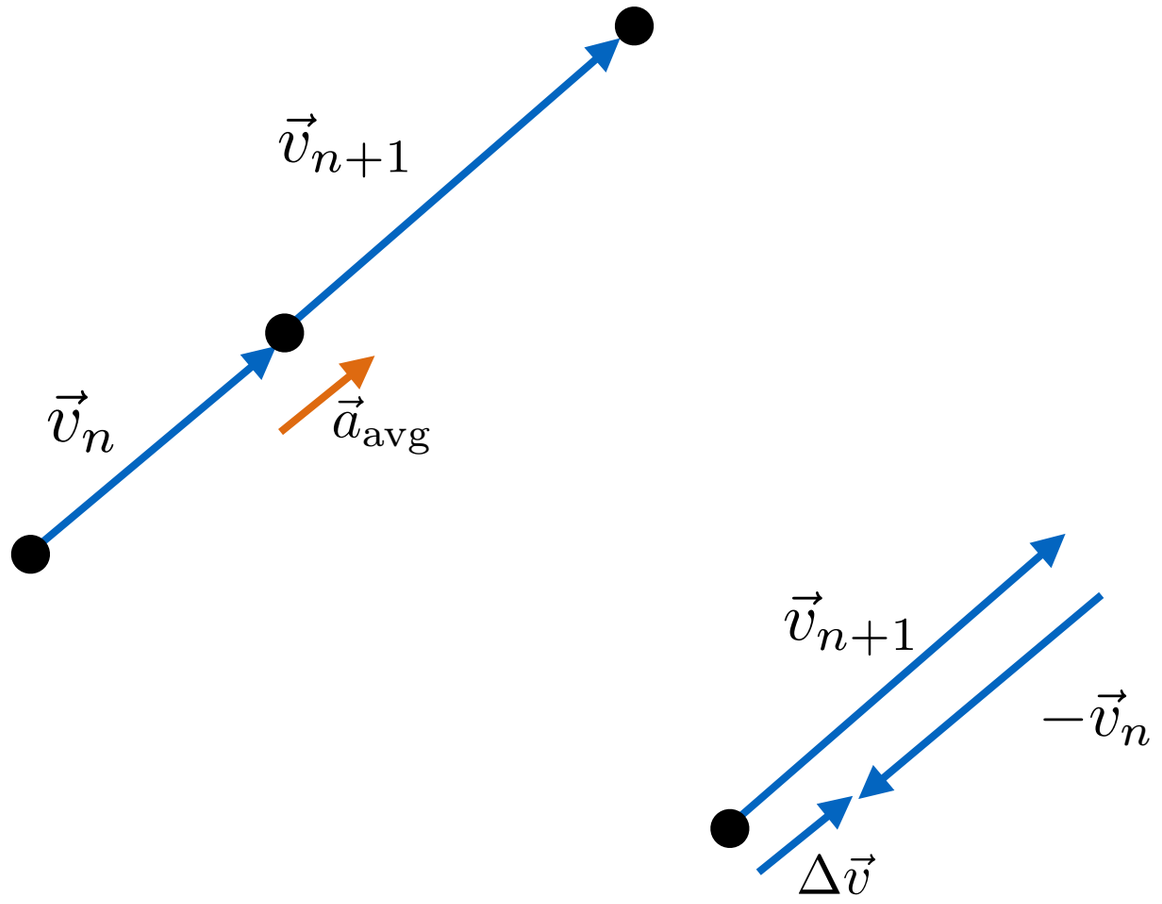

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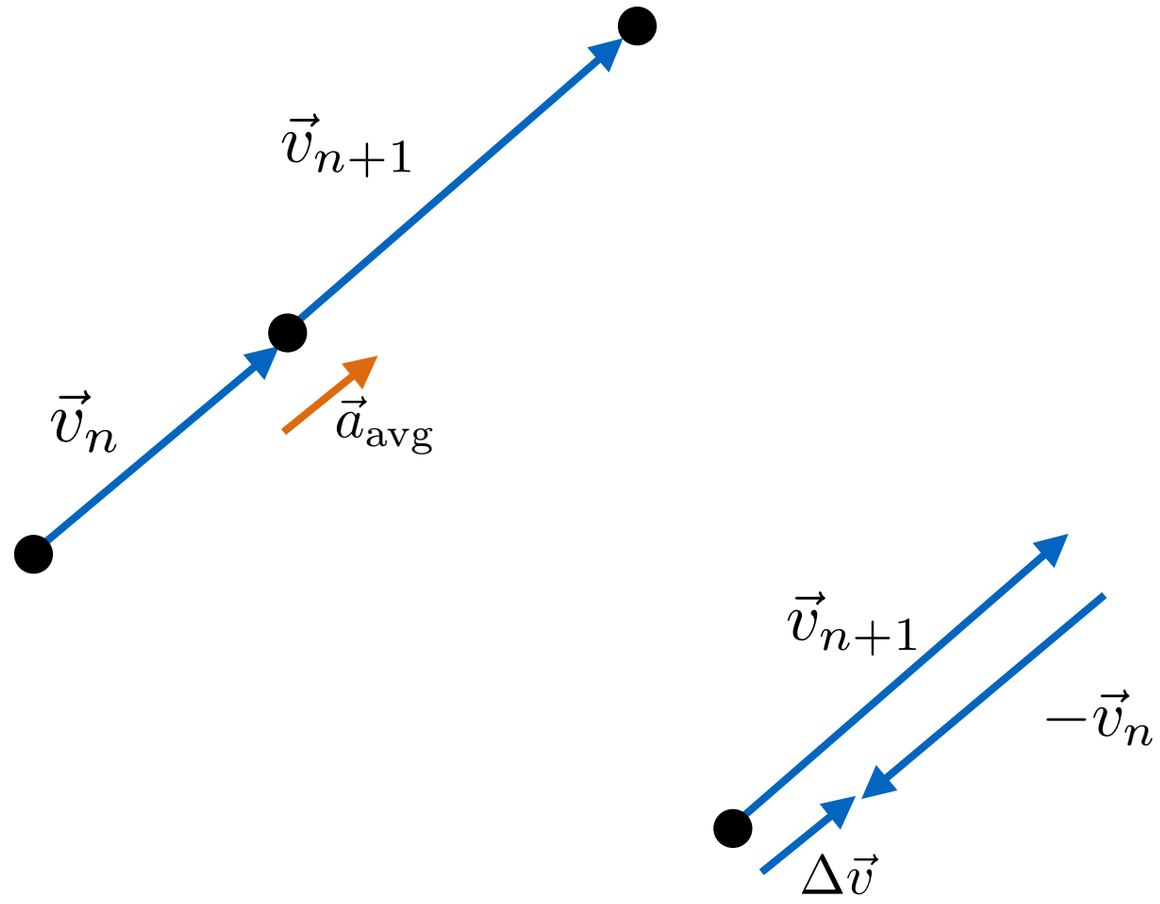
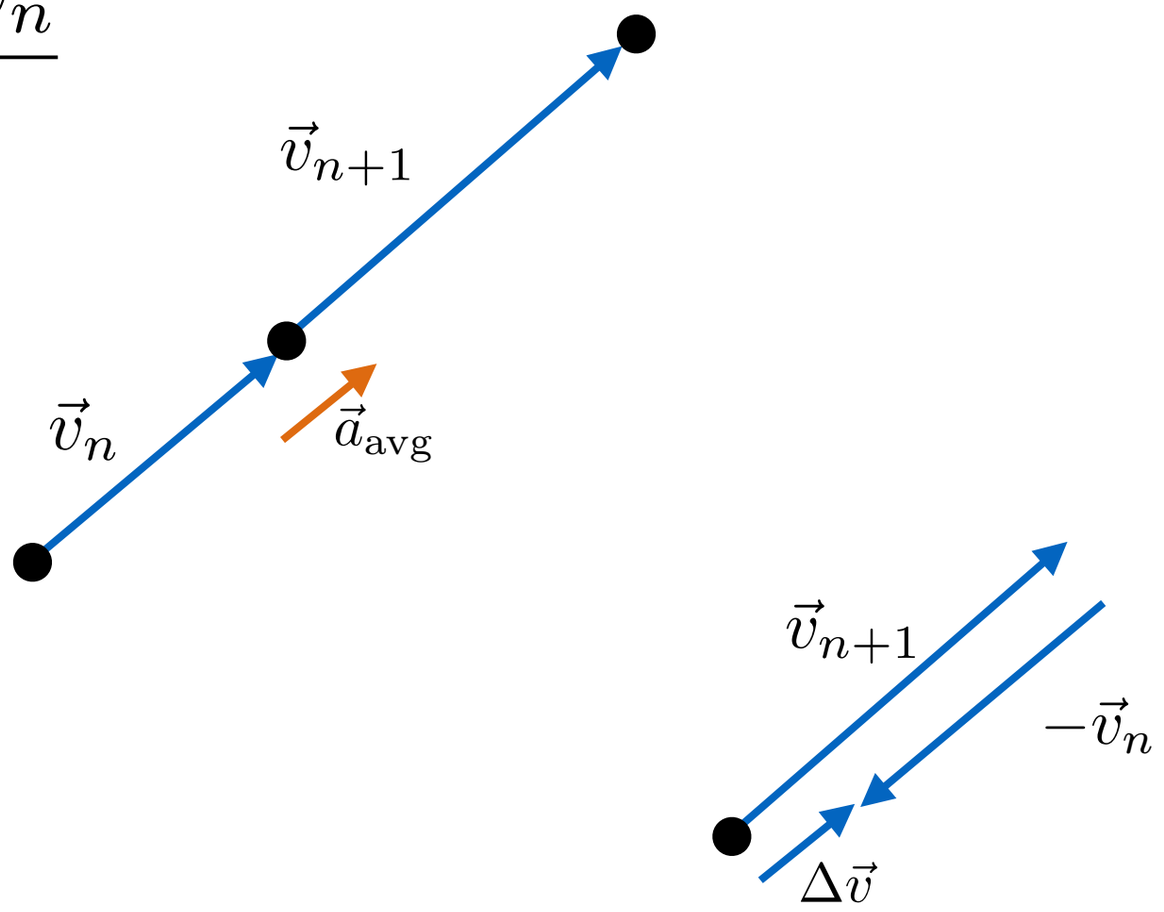


- Notice that the acceleration vectors goes beside the dots, not beside the velocity vectors.
- That is because each acceleration vector is the *difference* between *two* velocity vectors on either side of a dot.

Finding the Acceleration Vector

$$\vec{a}_{\text{avg}} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_{n+1} - \vec{v}_n}{\Delta t}$$



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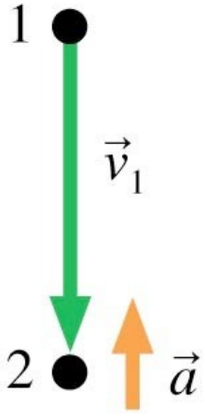
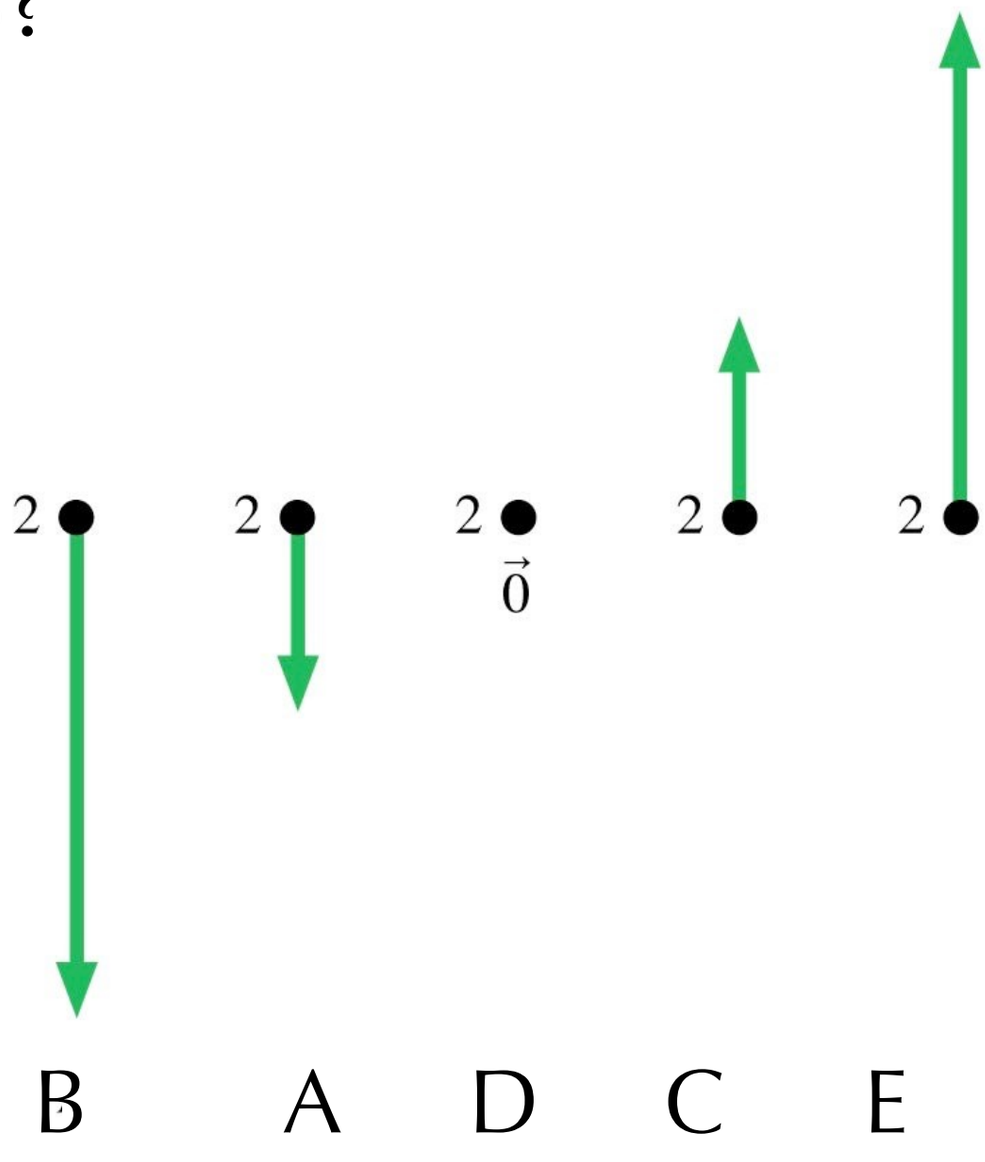
Question #6

A particle has velocity $\vec{v}_1$ as it accelerates from 1 to 2. What is its velocity vector $\vec{v}_2$ as it moves away from point 2 on its way to point 3?





Quiz

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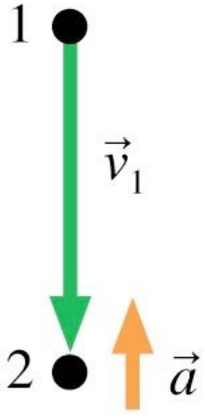

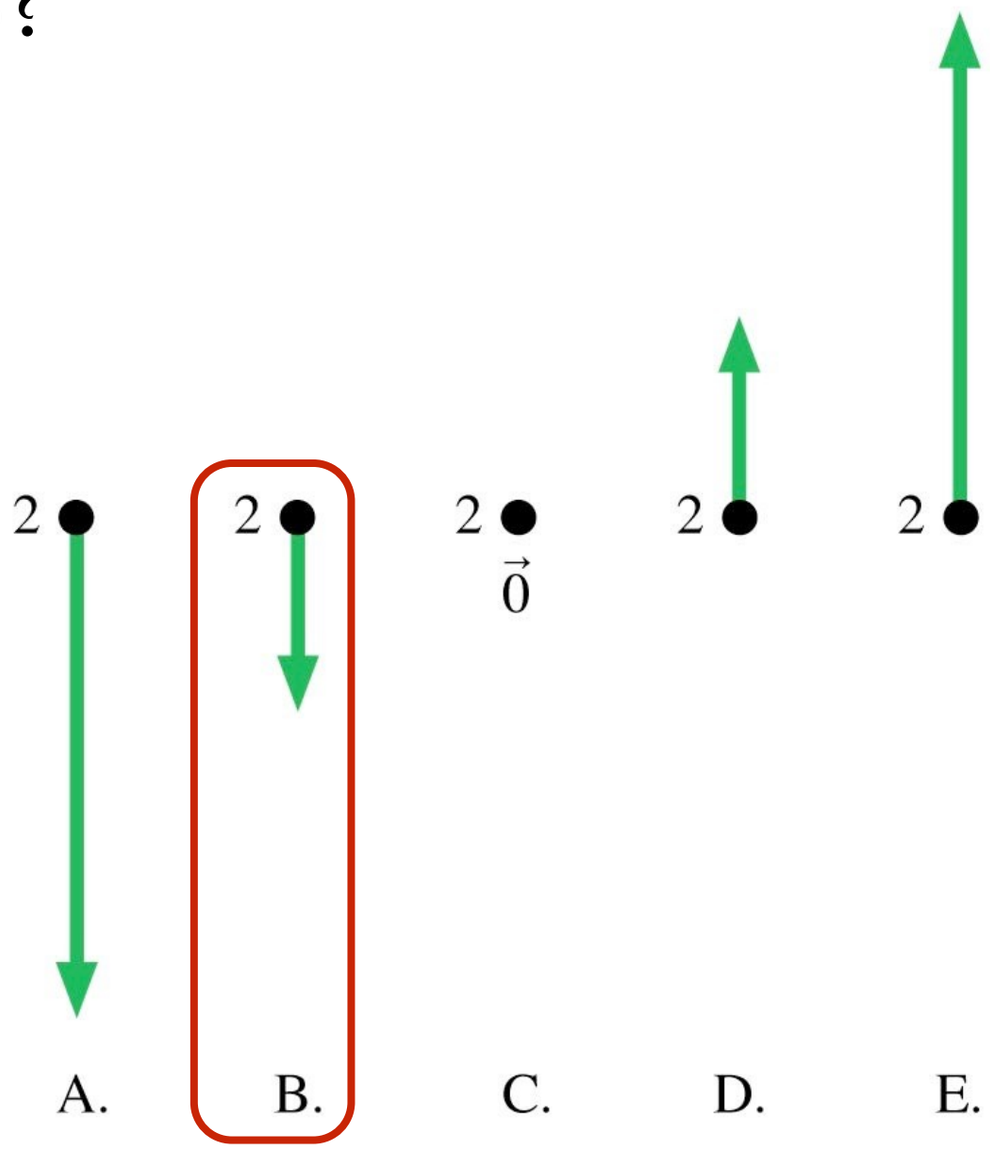

The Complete Motion Diagram

A complete motion diagram consists of:

a. The position of the object at each frame, represented as a dot.
b. Average velocity vectors connecting each dot in the motion diagram to the next dot. There is one velocity vector per two dots in the motion diagram. Label these vectors
c. Average acceleration vectors. There is one acceleration vector connecting two velocity vectors. The average acceleration vectors are placed at the location of the dots.

Example

A skier glides along a smooth, horizontal snow at constant speed, then speeds up going down a hill. Draw the skier's motion diagram

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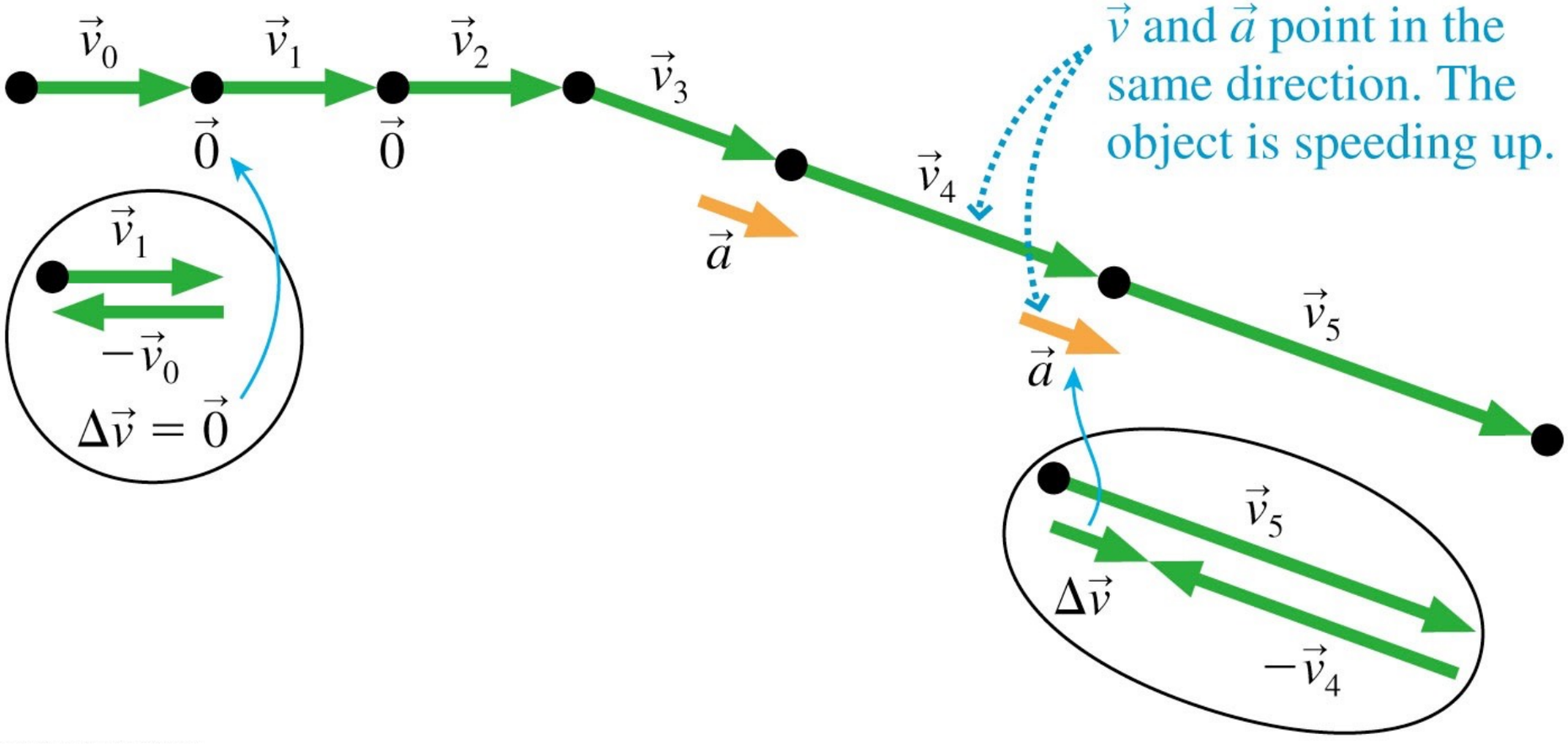
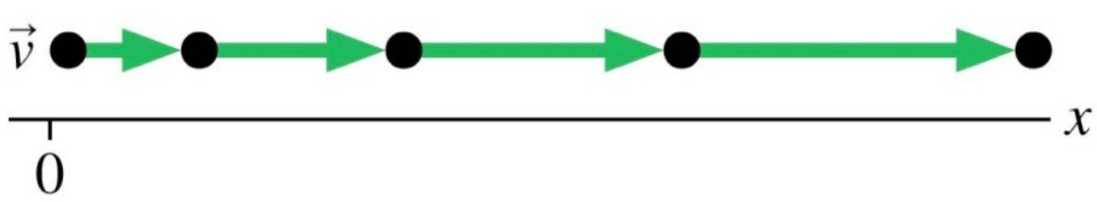


Question #7

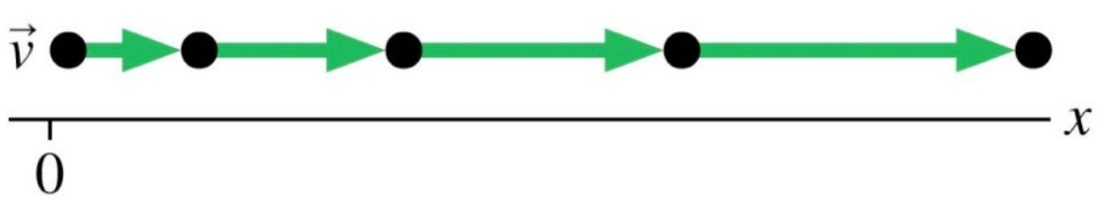
- Is the object speeding up or slowing down?



a) slowing down
b) .
c) speeding up
d) .
e) neither speeding up or slowing down.

Question #8

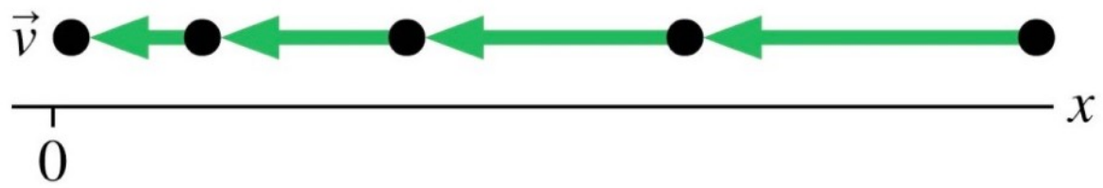
- What direction do the acceleration vectors point?



a) .
b) to the right.
c) to the left.
d) .
e) they are zero.

Question #9

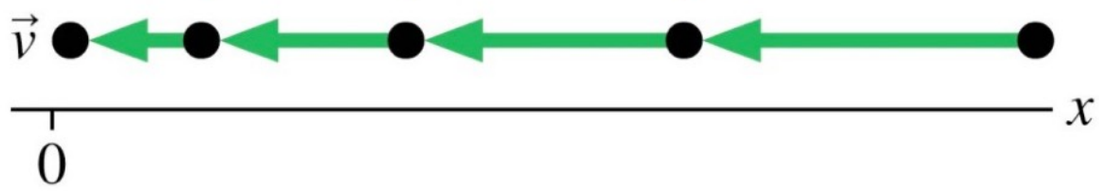
- Is the object speeding up or slowing down?



a) .
b) .
c) neither speeding up or slowing down.
d) slowing down
e) speeding up

Question #10

- What direction do the acceleration vectors point?



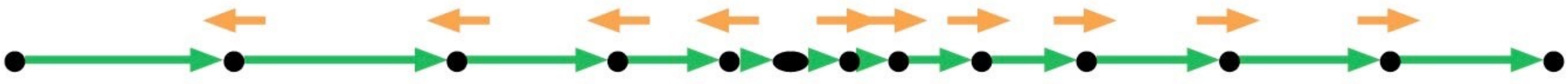
a) to the right.
b) to the left.
c) they are zero.
d) .
e) .

Question #11

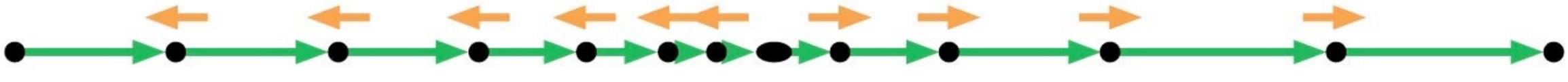
A cyclist riding at 20 mph sees a stop sign and actually comes to a complete stop in 4 s. He then, in 6 s, returns to a speed of 15 mph. Which is his motion diagram?

C

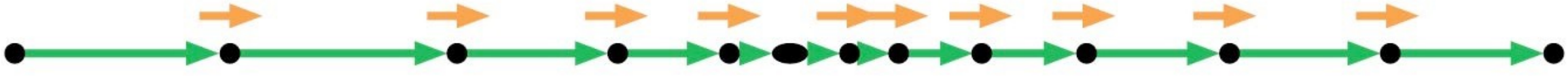
D



A



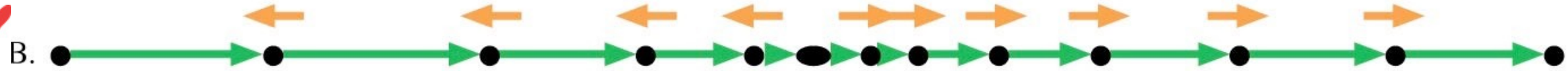
B



Quiz

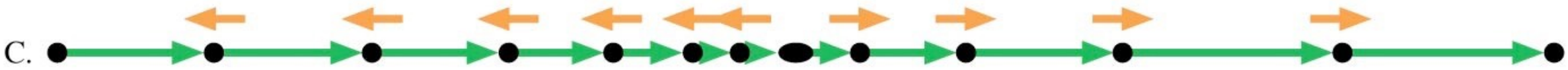
A cyclist riding at 20 mph sees a stop sign and actually comes to a complete stop in 4 s. He then, in 6 s, returns to a speed of 15 mph. Which is his motion diagram?

A.

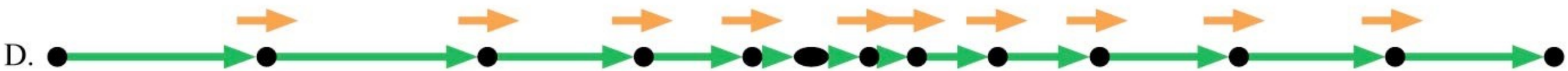


✔ B.

C.



D.



Quiz

A ball is tossed straight up in the air. At its very highest point, the ball's acceleration vector $\vec{a}$

a. Points up.

b. Is zero.

c. Points down.

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In fact, the acceleration vector points down as the ball rises, at the highest point, and as it falls.