You can draw here

Physics 111 - Class 2B
Vectors II

Do not draw in/on this box!

September 15, 2021

You can draw here

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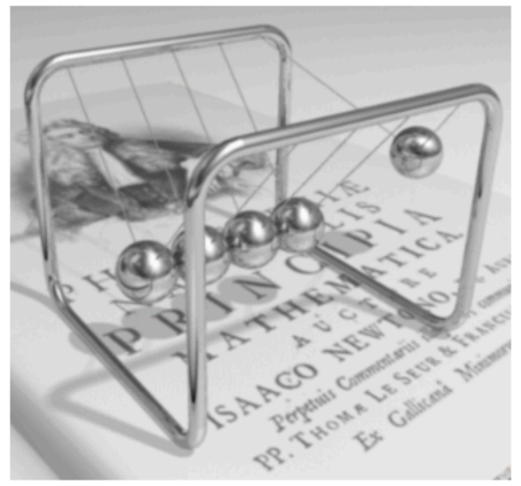
Logistics/Announcements

- Lab this week: Introduction
- HW due this week on Thursday at 6 PM
  - I released it a bit late, so I added +24 hours to the grace period
- Test/Bonus Test: No test this week!
- Learning Log 2 due on Saturday at 6 PM
- HW and LL deadlines have a 48 hour grace period

Class Outline

- Introduction to Chapters 1 and 2
- Clicker Questions
- Problem Solving Template
- Activity: Ladybug Walker
- Debrief



Physics 111

Videos

Below are the assigned videos for this week. The videos are collapsible so once you're done with one, you can move to the next one. In the sidebar on the right, you can use the checklists to keep track of what's done.

Checklist of items

- Video 1
- Video 2
- Video 3
- Video 3
- Video 3

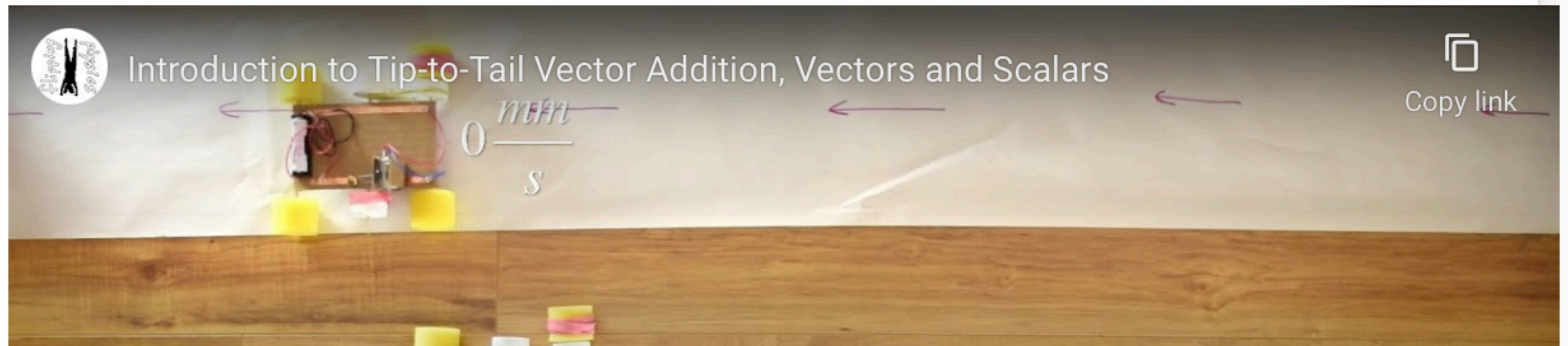
Required Videos

1. Introduction to Significant Figures

- Notes
- Direct link to Mr. P's page

2. Working with Significant Figures

3. Introduction to Tip-to-Tail Vector Addition



Vectors

Various relations between two vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$.

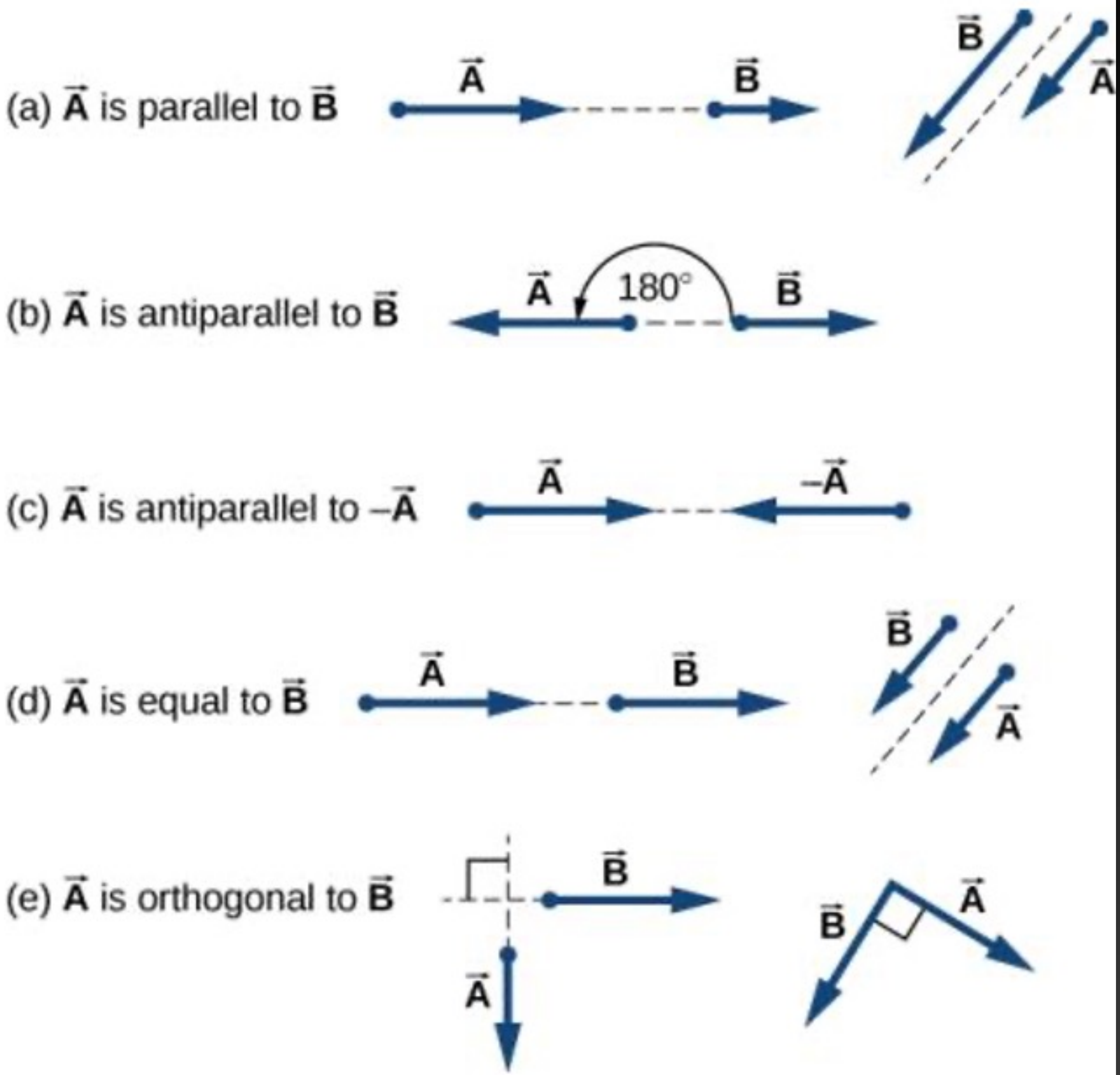
(a) $\vec{\mathbf{A}} \neq \vec{\mathbf{B}}$ because $A \neq B$.

(b) $\vec{\mathbf{A}} \neq \vec{\mathbf{B}}$ because they are not parallel and $A \neq B$.

(c) $\vec{\mathbf{A}} \neq -\vec{\mathbf{A}}$ because they have different directions (even though $\vec{\mathbf{A}} = \overrightarrow{-\mathbf{A}} = \boldsymbol{A}$).

(d) $\vec{\mathbf{A}} = \vec{\mathbf{B}}$ because they are parallel and have identical magnitudes $A = B$.

(e) $\vec{\mathbf{A}} \neq \vec{\mathbf{B}}$ because they have different directions (are not parallel); here, their directions differ by 90°—meaning, they are orthogonal.



Introduction

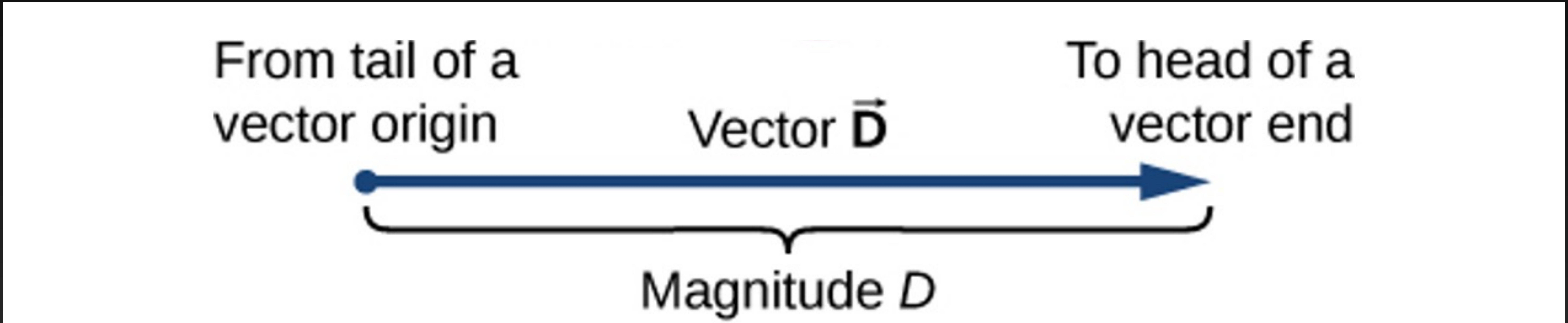
Table of contents

Search this book

My highlights

Figure 2.1 A signpost gives information about distances and directions to towns or to other locations relative to the location of the signpost. Distance is a scalar quantity. Knowing the distance alone is not enough to get to the town; we must also know the direction from the signpost to the town. The direction, together with the distance, is a vector quantity commonly called the displacement vector. A signpost, therefore, gives information about displacement vectors from the signpost to towns. (credit: modification of work by "studio tdes"/Flickr, thedailyenglishshow.com)

What is a vector?



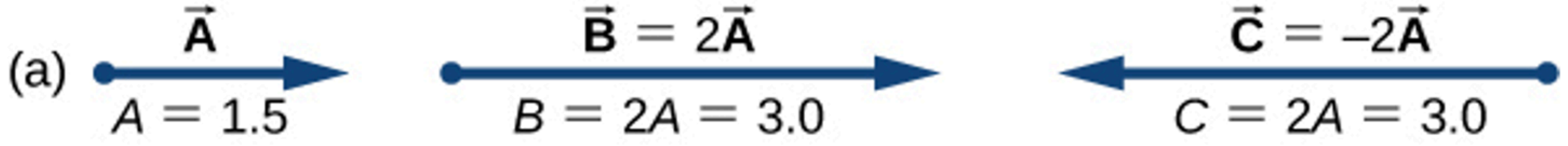
Vectors

Algebra of vectors in one dimension.

Vectors

Algebra of vectors in one dimension.

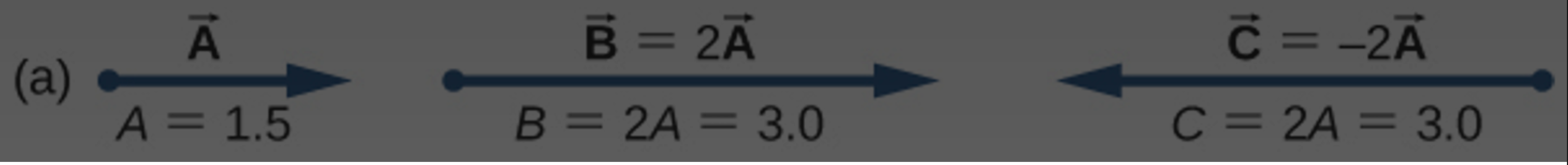
(a) Multiplication by a scalar.



Vectors

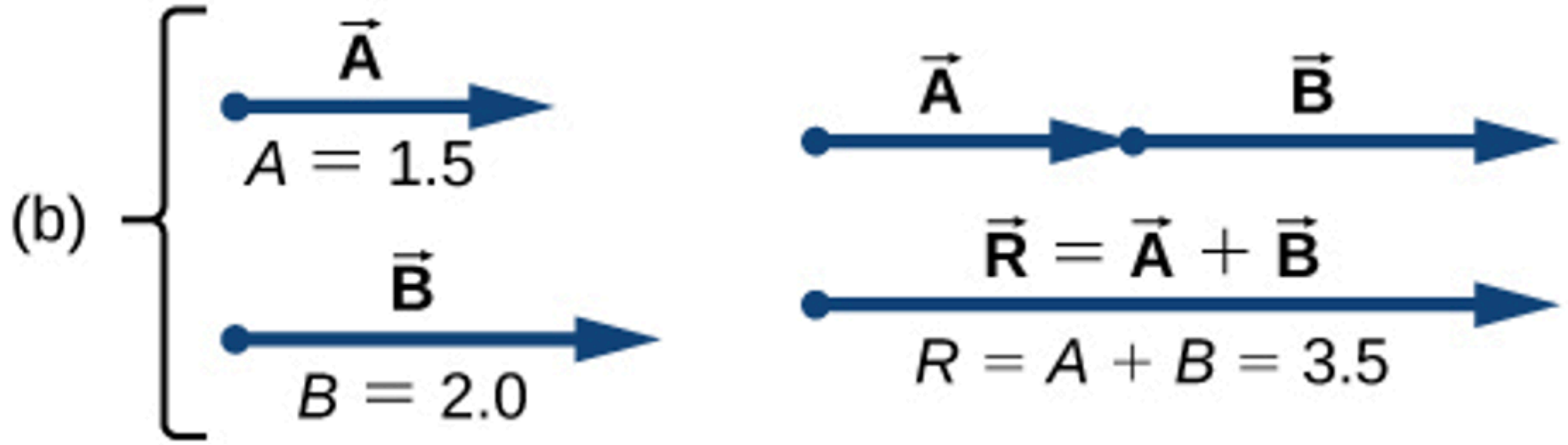
Algebra of vectors in one dimension.

(a) Multiplication by a scalar.



(b) Addition of two vectors

$\vec{\mathbf{R}}$ is called the *resultant* of vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$.



Vectors

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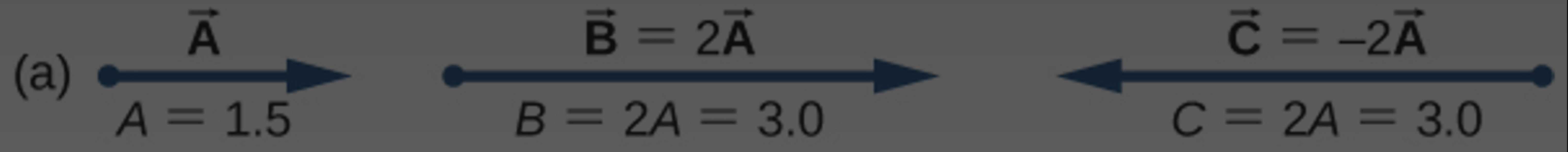

(b) Addition of two vectors

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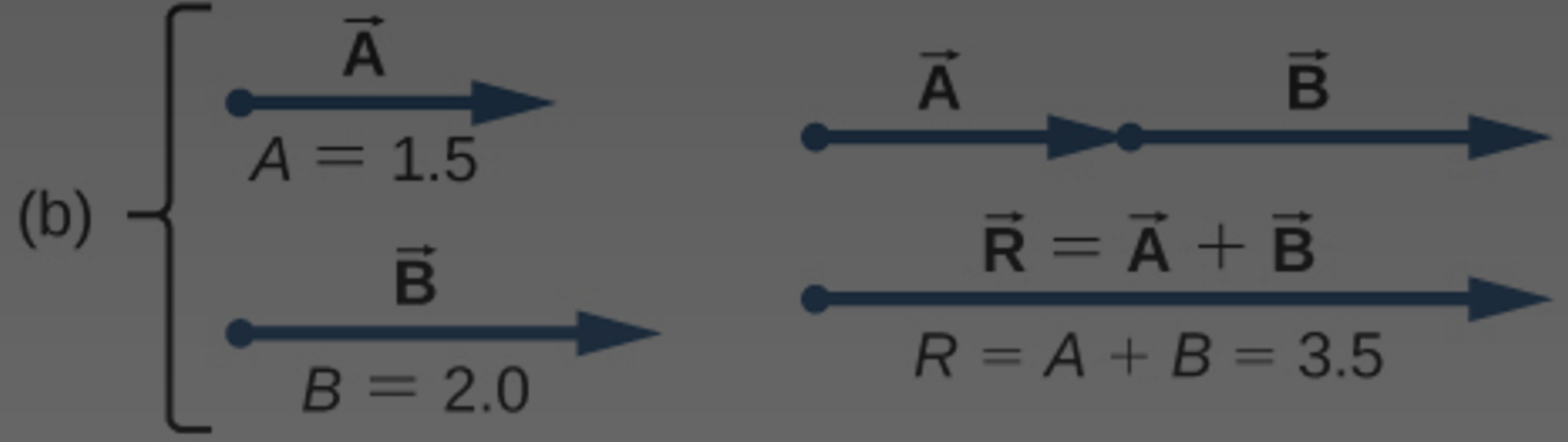
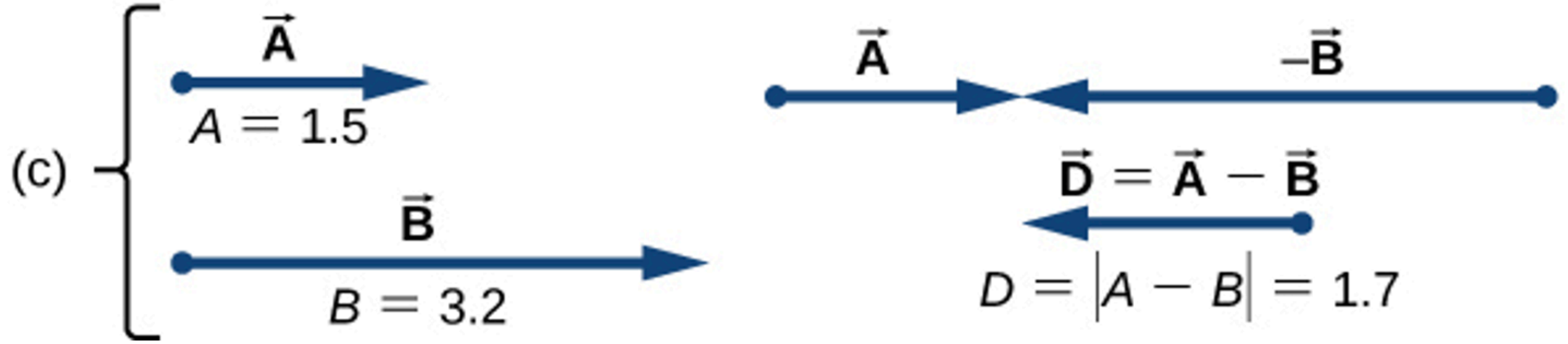


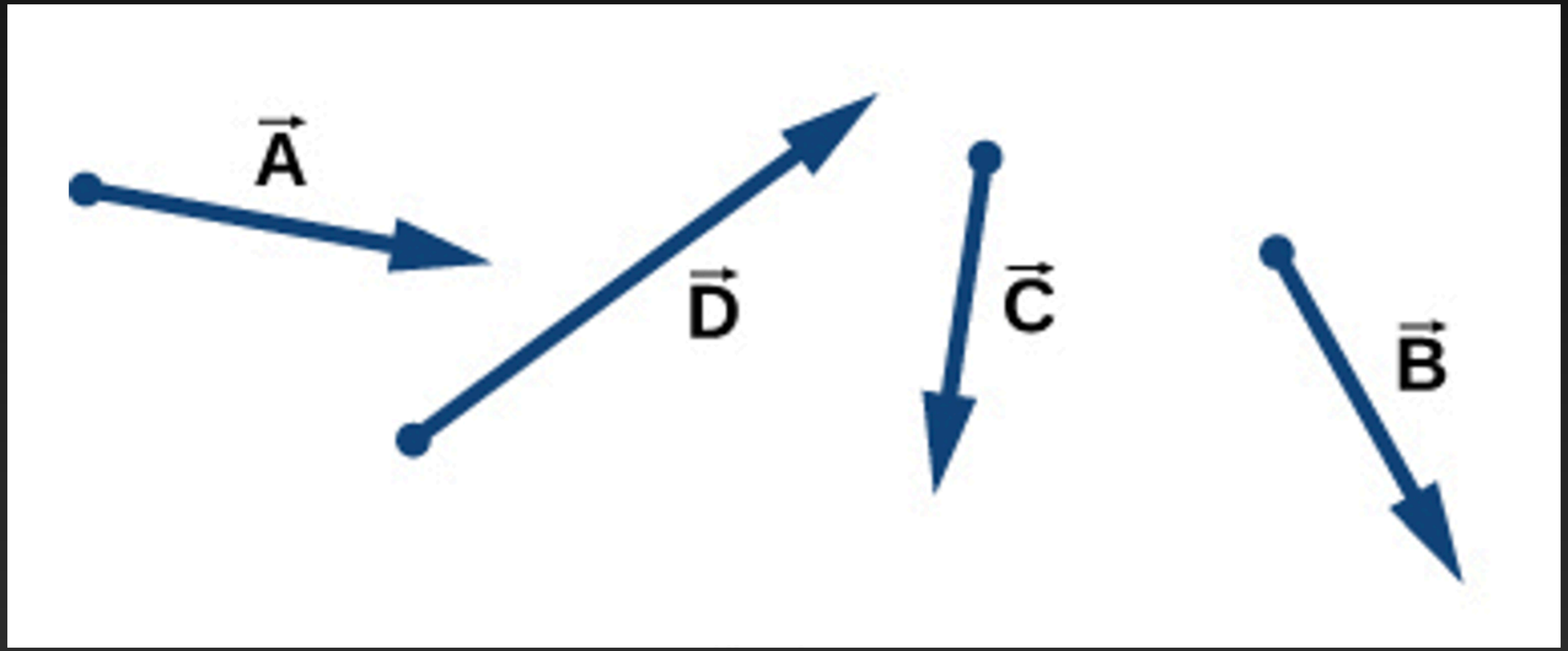
(c) Subtraction of two vectors

$\vec{\mathbf{D}}$ is the difference of vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$.



Tail-to-head Method

Here are four vectors, with varying lengths and directions.



What is the resultant vector?

$$\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$$

Tail-to-head Method

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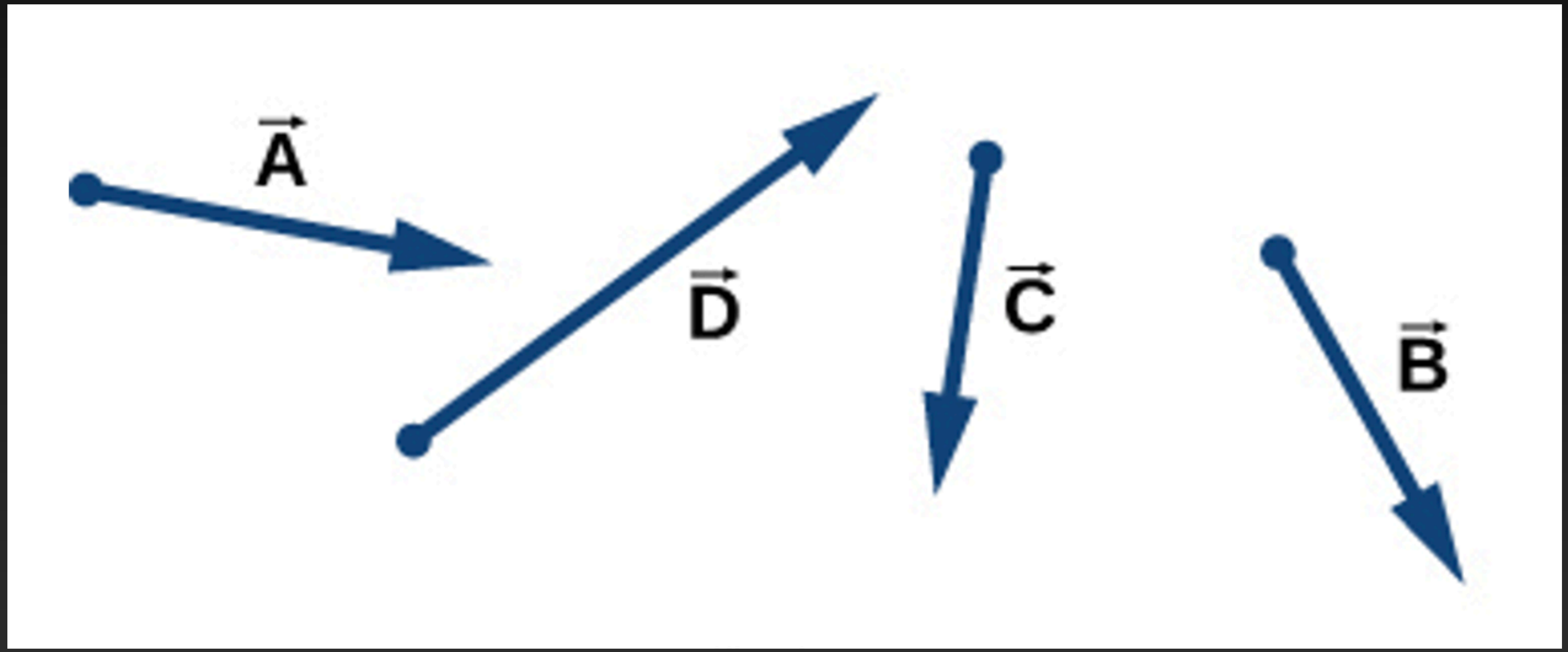
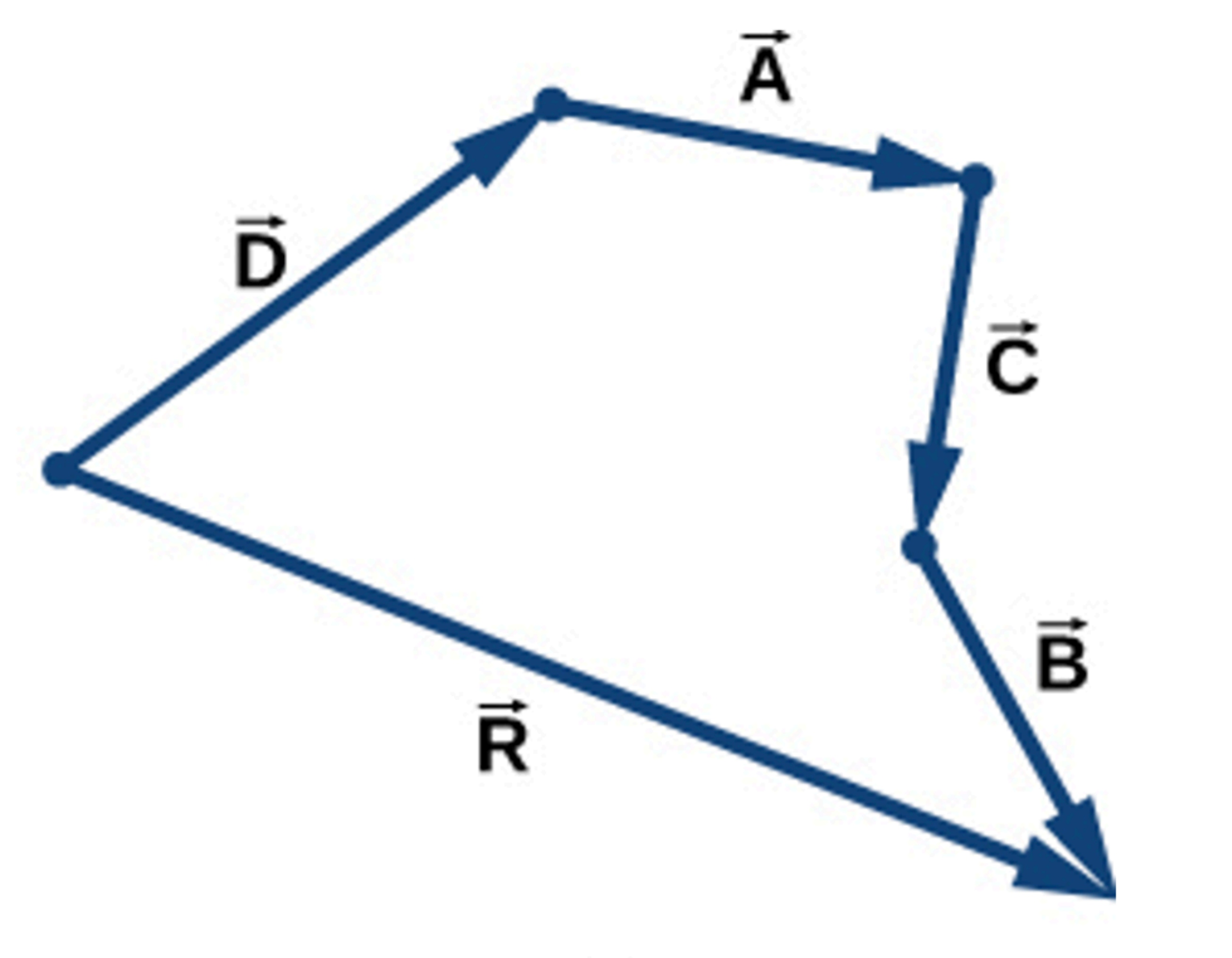


What is the resultant vector?

$$\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$$



CQ.2.2

Maud sends her bowling ball straight down the center of the lane, getting a strike. The ball is brought back to the holder mechanically. What are the ball's net displacement and distance traveled?

a) Displacement of the ball is twice the length of the lane, while the distance is zero.

b) Displacement of the ball is zero, while the distance is twice the length of the lane.

c) Both the displacement and distance for the ball are equal to zero.

d) Both the displacement and distance for the ball are twice the length of the lane.

A B C D E

CQ.2.2

Maud sends her bowling ball straight down the center of the lane, getting a strike. The ball is brought back to the holder mechanically. What are the ball's net displacement and distance traveled?

a) Displacement of the ball is twice the length of the lane, while the distance is zero.

✓ b) Displacement of the ball is zero, while the distance is twice the length of the lane.

c) Both the displacement and distance for the ball are equal to zero.

d) Both the displacement and distance for the ball are twice the length of the lane.

Detailed solution: Displacement of the ball is zero, while the distance is twice the length of the lane.

A

B

C

D

E

CQ.2.3

Terry walks south 39 m, then north 27 m, and then north again 16 m. What are the distance and displacement of her motion?

a) Terry covers a total distance of 82 m, and her displacement is 4 m towards east.

b) Terry covers a total distance of 82 m, and her displacement is 4 m towards west.

c) Terry covers a total distance of 82 m, and her displacement is 4 m towards north.

d) Terry covers a total distance of 82 m, and her displacement is 4 m towards south.

A B C D E

CQ.2.3

Terry walks south 39 m, then north 27 m, and then north again 16 m. What are the distance and displacement of her motion?

a) Terry covers a total distance of 82 m, and her displacement is 4 m towards east.

b) Terry covers a total distance of 82 m, and her displacement is 4 m towards west.

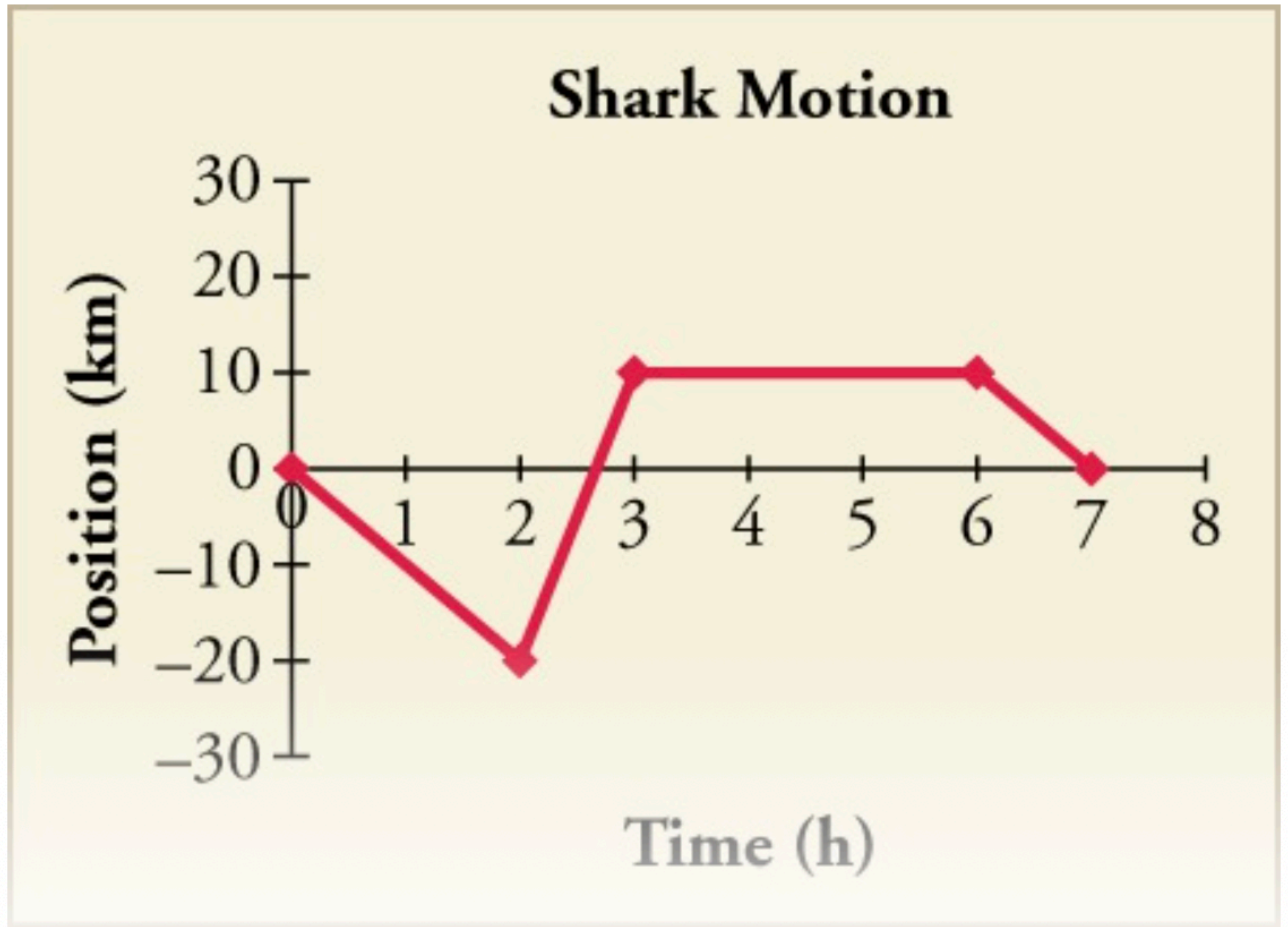
✓ c) Terry covers a total distance of 82 m, and her displacement is 4 m towards north.

d) Terry covers a total distance of 82 m, and her displacement is 4 m towards south.

Detailed solution: Displacement $= \Delta d = d_f - d_o$ = (-39 m + 27 m + 16 m) - 0 = +4 m, or 4 m north; distance = 39 m + 27 m + 16 m = 82 m

A B C D E

CQ.2.4



a) Total distance is 0 km, and the net displacement is 0 km.

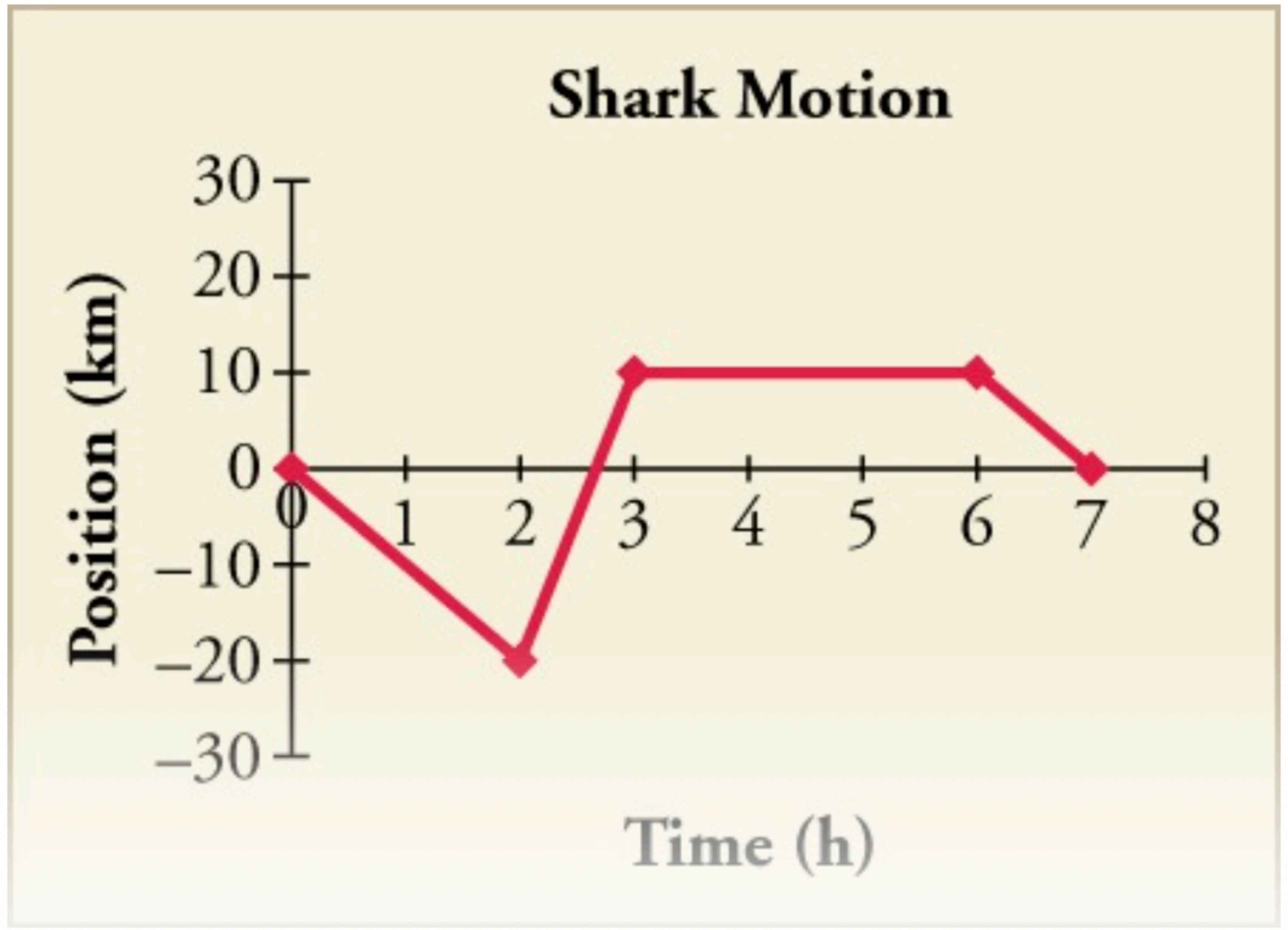
b) Total distance is 10 km, and the net displacement is 0 km.

c) Total distance is 20 km, and the net displacement is 10 km.

d) Total distance is 60 km, and the net displacement is 0 km.

A B C D E

CQ.2.4



a) Total distance is 0 km, and the net displacement is 0 km.

b) Total distance is 10 km, and the net displacement is 0 km.

c) Total distance is 20 km, and the net displacement is 10 km.

✓ d) Total distance is 60 km, and the net displacement is 0 km.

Detailed solution: The total distance is 60 km, and the net displacement is 0 km.

A B C D E

Activity

EXAMPLE 2.1

A Ladybug Walker

A long measuring stick rests against a wall in a physics laboratory with its 200-cm end at the floor. A ladybug lands on the 100-cm mark and crawls randomly along the stick. It first walks 15 cm toward the floor, then it walks 56 cm toward the wall, then it walks 3 cm toward the floor again. Then, after a brief stop, it continues for 25 cm toward the floor and then, again, it crawls up 19 cm toward the wall before coming to a complete rest (Figure 2.8). Find the vector of its total displacement and its final resting position on the stick.

Problem Solving Template

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH **16,** 010123 (2020)

Template for teaching and assessment of problem solving in introductory physics

E. W. Burkholder,[1,*] J. K. Miles,[2] T. J. Layden,[2] K. D. Wang,[3]
A. V. Fritz,[4] and C. E. Wieman[1,3]

Reference: Template for teaching and assessment of problem solving in introductory physics

1. Framing

- Visual Representation
- Assumptions and Simplifications
- Relevant Concepts
- Information Needed
- Similar Problems

2. Planning

- Solution Plan
- Rough Estimate

3. Execution

Carry-out Plan for solving
- Work in algebra/symbols until the BITTER end
- Plug in numbers at the LAST step

4. Answer Checking

- Compare to Estimate
- Units Check
- Limits Test
- Getting (UnStuck)

Reference: Template for teaching and assessment of problem solving in introductory physics

Debrief

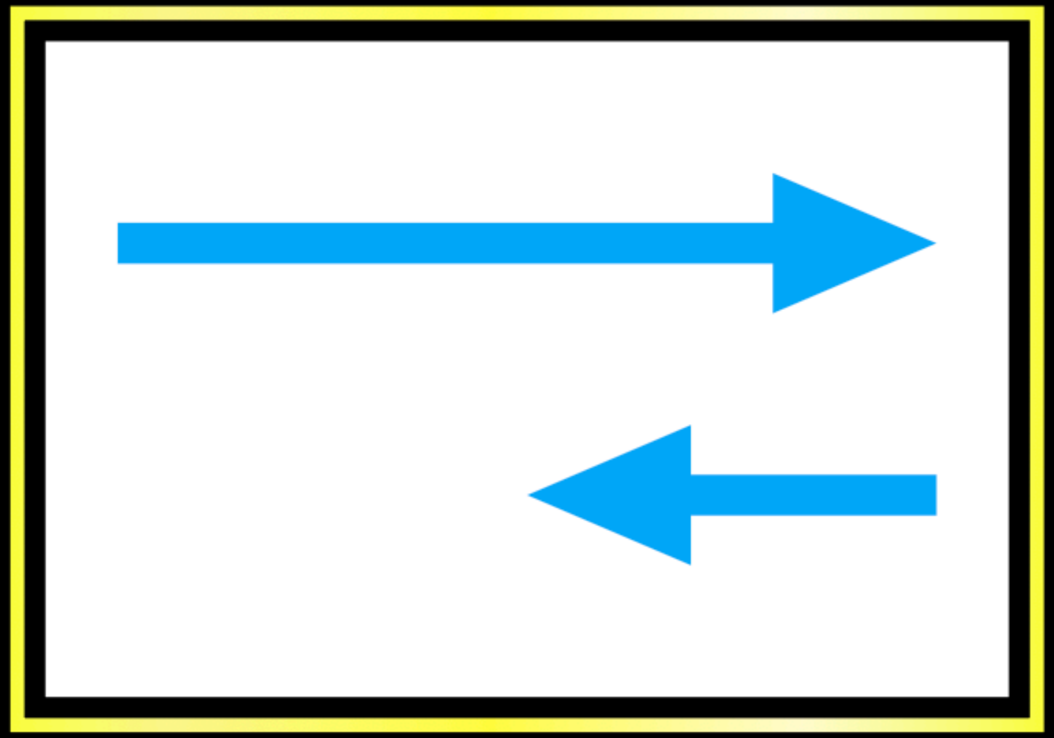
Solution

The resultant of all the displacement vectors is

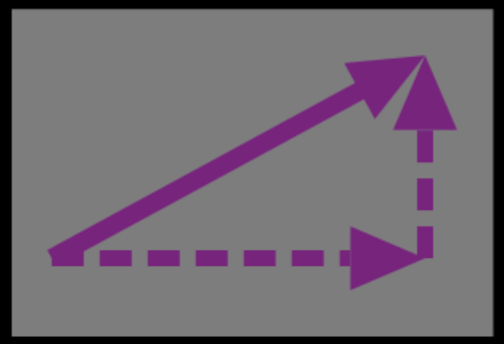
$$\begin{aligned}\vec{\mathbf{D}} &= \vec{\mathbf{D}}_1 + \vec{\mathbf{D}}_2 + \vec{\mathbf{D}}_3 + \vec{\mathbf{D}}_4 + \vec{\mathbf{D}}_5 \\ &= (15\text{ cm})(+\hat{\mathbf{u}}) + (56\text{ cm})(-\hat{\mathbf{u}}) + (3\text{ cm})(+\hat{\mathbf{u}}) + (25\text{ cm})(+\hat{\mathbf{u}}) + (19\text{ cm})(-\hat{\mathbf{u}}) \\ &= (15 - 56 + 3 + 25 - 19)\text{cm}\hat{\mathbf{u}} \\ &= -32\text{ cm}\hat{\mathbf{u}}.\end{aligned}$$

In this calculation, we use the distributive law given by Equation 2.9. The result reads that the total displacement vector points away from the 100-cm mark (initial landing site) toward the end of the meter stick that touches the wall. The end that touches the wall is marked 0 cm, so the final position of the ladybug is at the (100 – 32)cm = 68-cm mark.

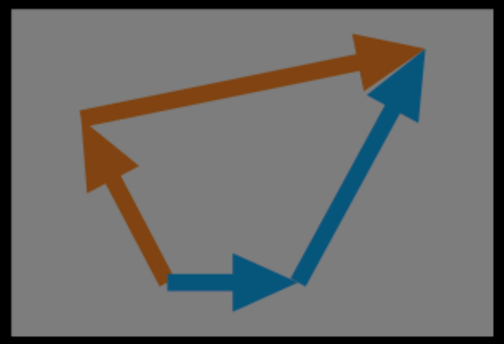
Vector Addition



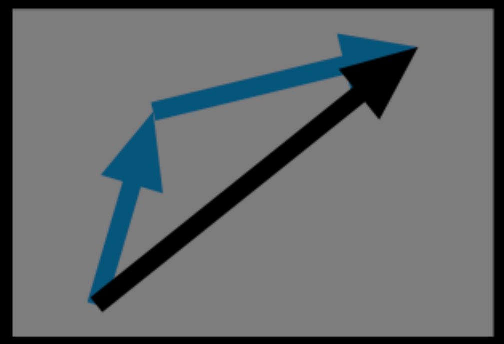
Explore 1D



Explore 2D



Lab



Equations

See you next class!