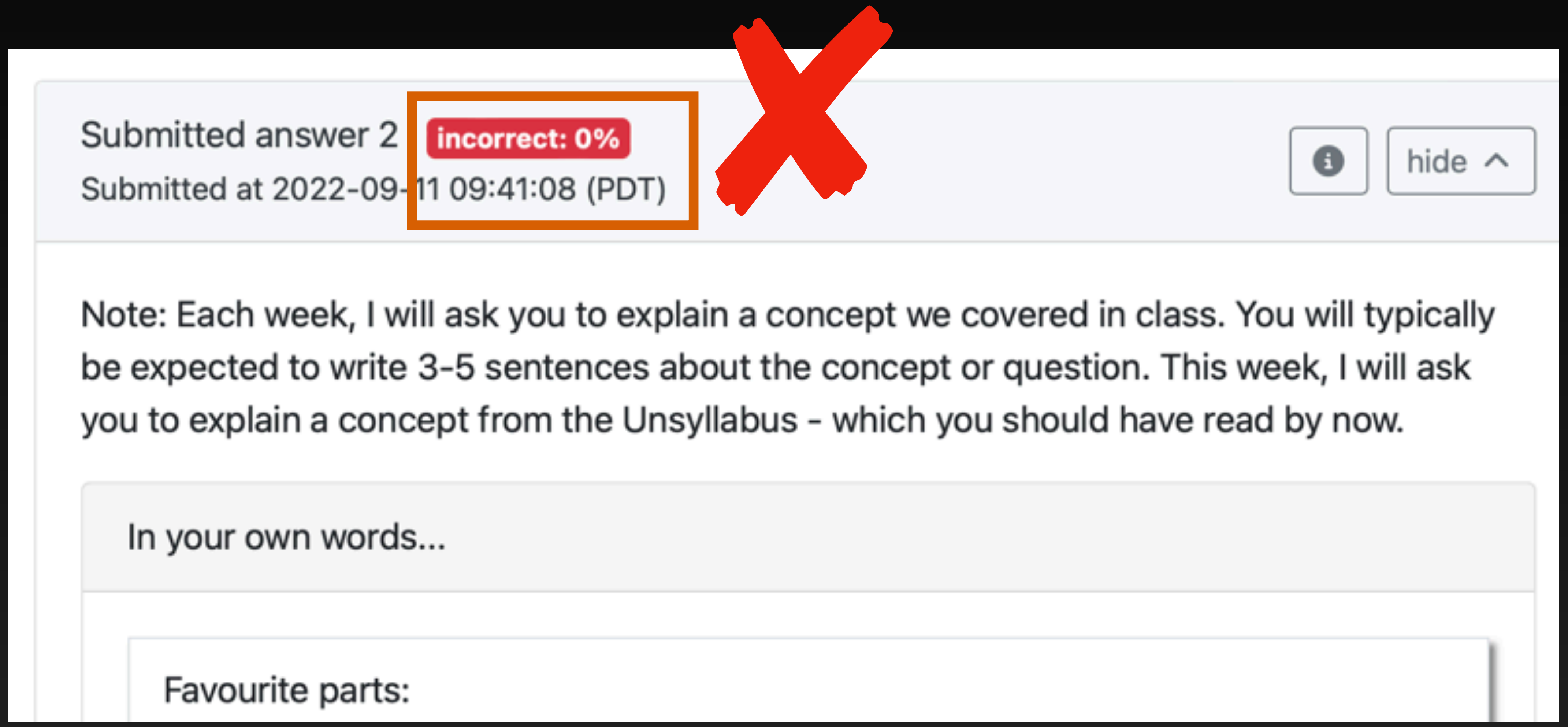
Physics 111 - Class 2A
Displacement and Vectors

September 12, 2022

Logistics/Announcements

- Lab this week: Please go to your labs!
- HW2 due this week on Thursday at 6 PM
  - HW1 is the Math Diagnostic and is not for marks but can be used as one of your 9 HW assignments that count
- Test 1 will be held on Friday during class, Bonus Test 1 next week
- Learning Log 1 was due on Saturday at 6 PM
  - With the grace period, it's still available until 6 PM today.
- HW and LL deadlines have a 48 hour grace period

Learning Log #1



- Sorry about the “incorrect:0%” tag on your LL1 questions!
- I will be grading these questions manually so it will say 0% until I look at it
- I have changed this behaviour for future learning logs!

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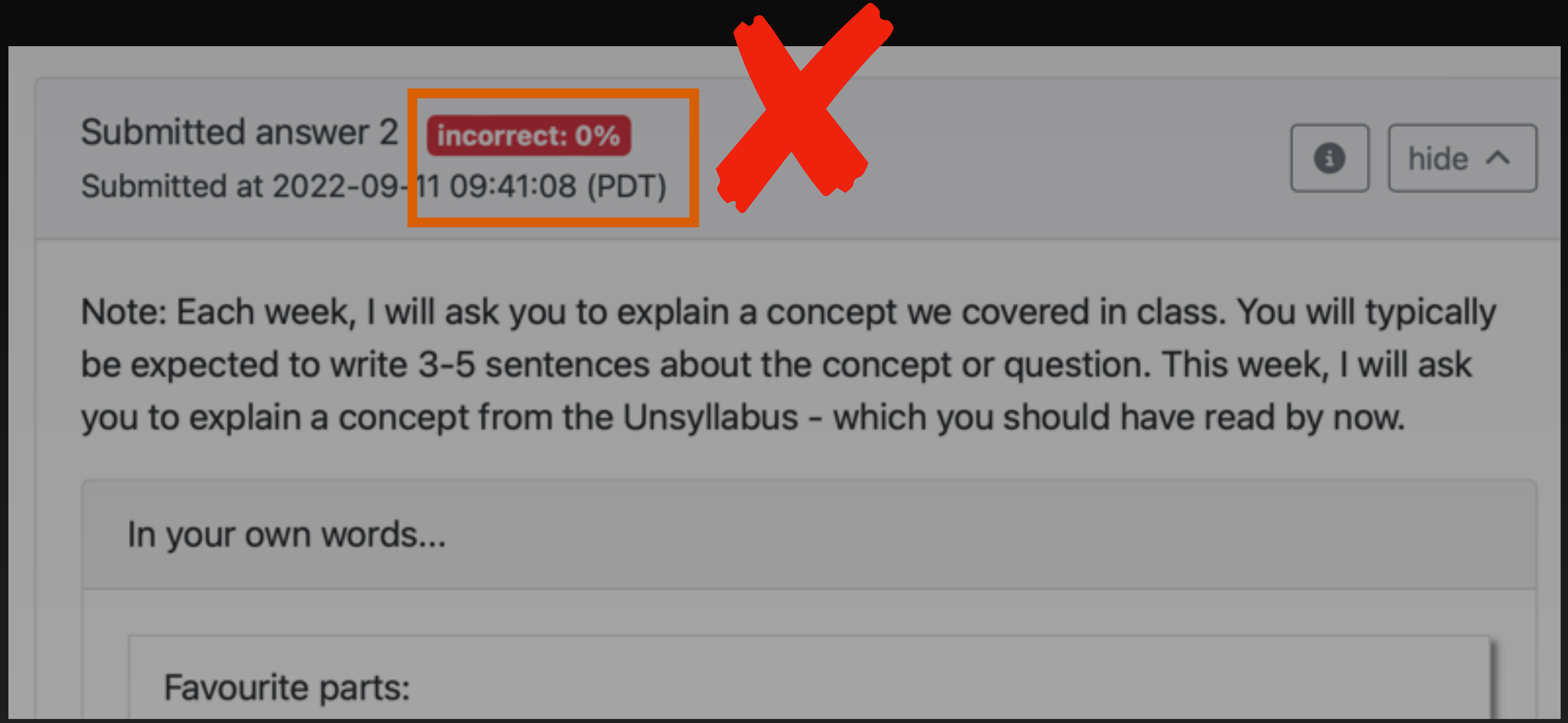

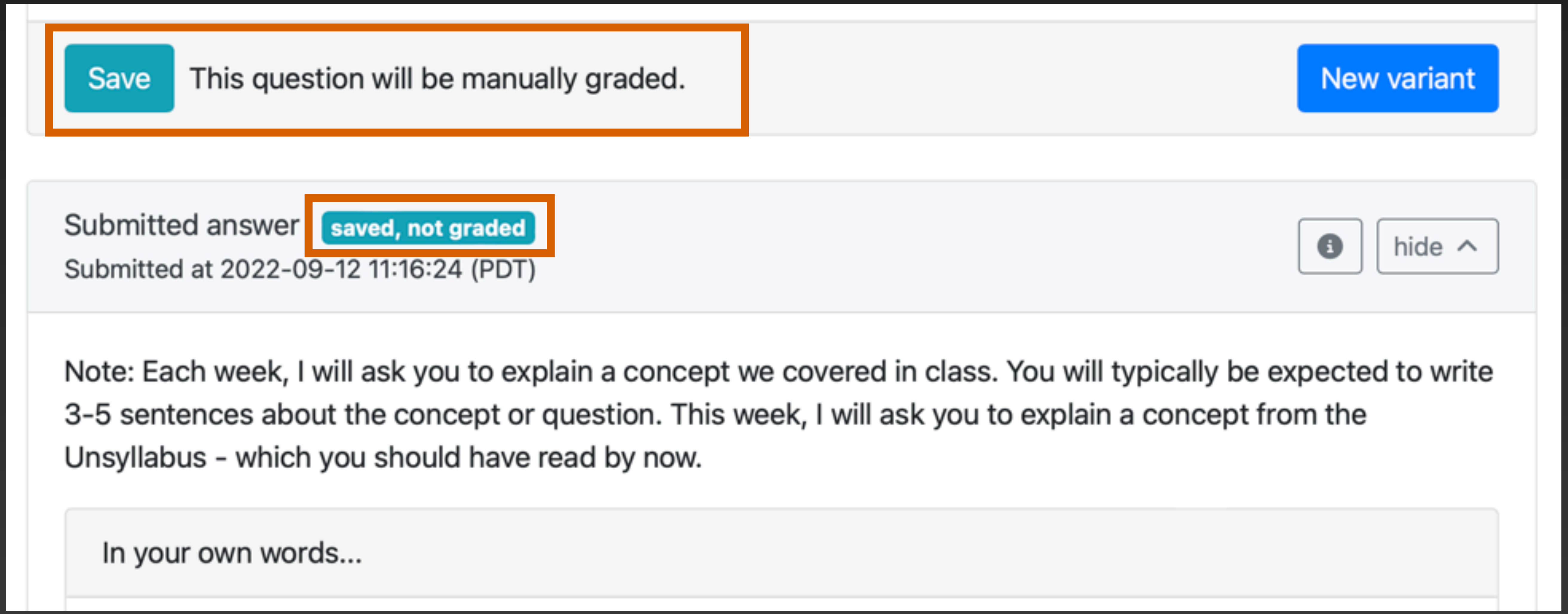

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Class Outline

- Introduction to Chapters 1 and 2
- Clicker Questions
- Problem Solving Template
- Activity
- Debrief
- Growth Mindset

Figure 1.1 This image might be showing any number of things. It might be a whirlpool in a tank of water or perhaps a collage of paint and shiny beads done for art class. Without knowing the size of the object in units we all recognize, such as meters or inches, it is difficult to know what we're looking at. In fact, this image shows the Whirlpool Galaxy (and its companion galaxy), which is about 60,000 light-years in diameter (about 6×10^{17} km across). (credit: modification of work by S. Beckwith (STScI) Hubble Heritage Team, (STScI/AURA), ESA, NASA)

Chapter Outline

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

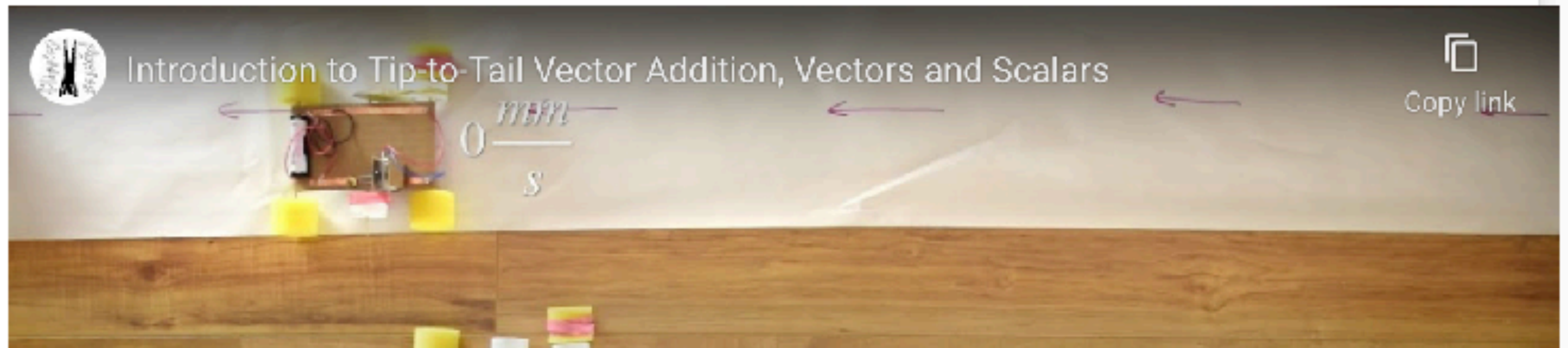
Required Videos

1. Introduction to Significant Figures

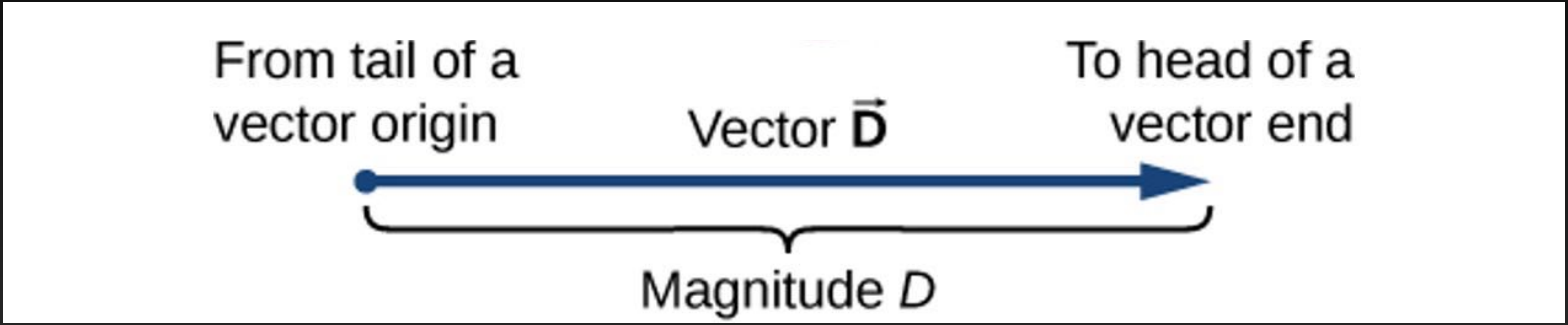
- Notes
- Direct link to Mr. P's page

2. Working with Significant Figures

3. Introduction to Tip-to-Tail Vector Addition



What is a vector?



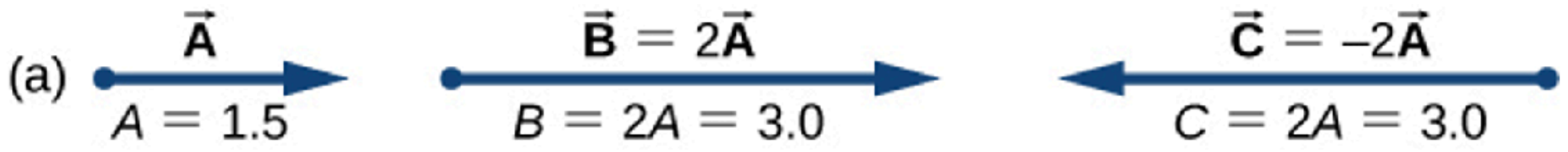
Vectors

Algebra of vectors in one dimension.

Vectors

Algebra of vectors in one dimension.

(a) Multiplication by a scalar.



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Algebra of vectors in one dimension.

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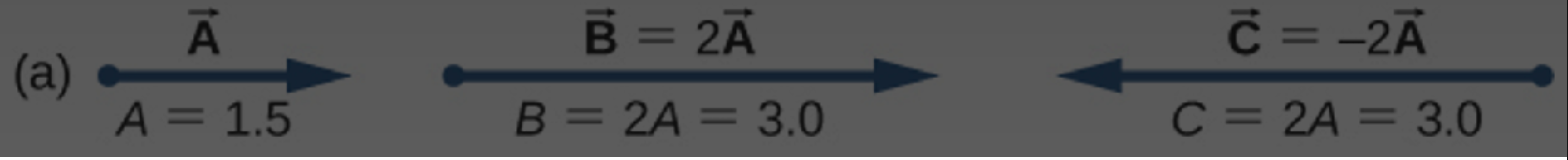
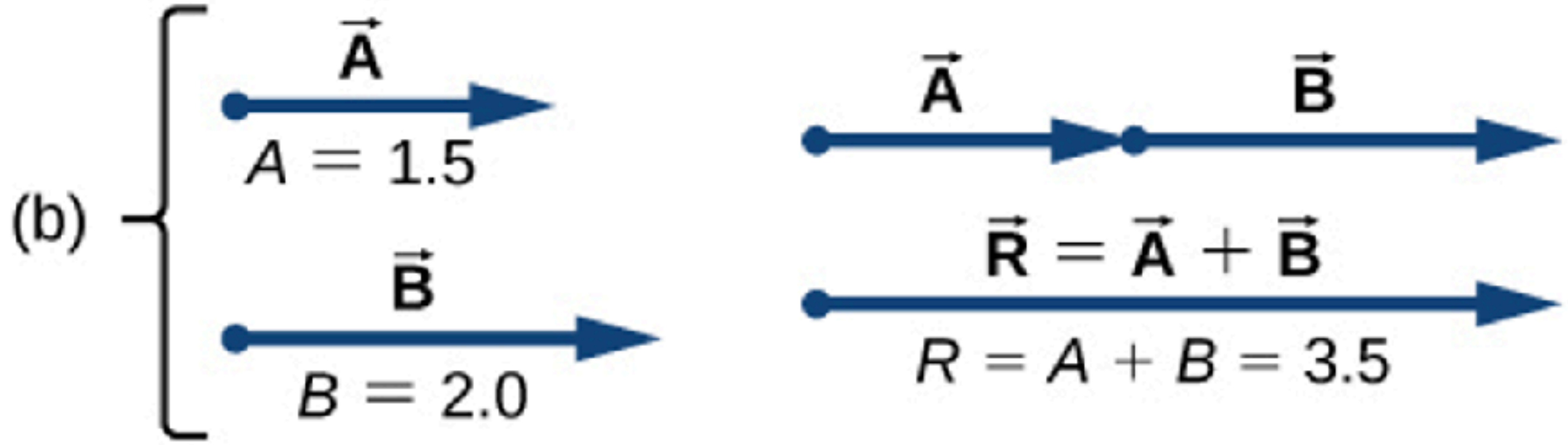


(b) Addition of two vectors

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



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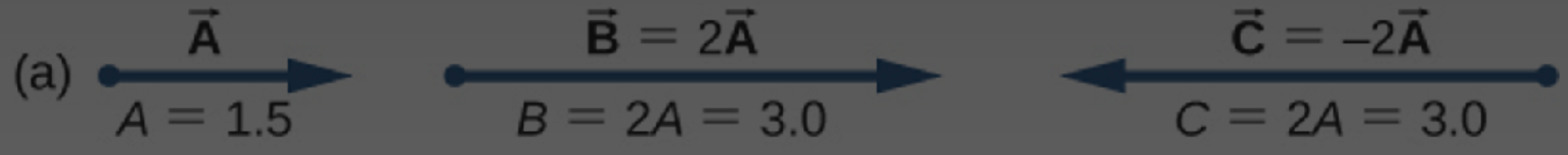

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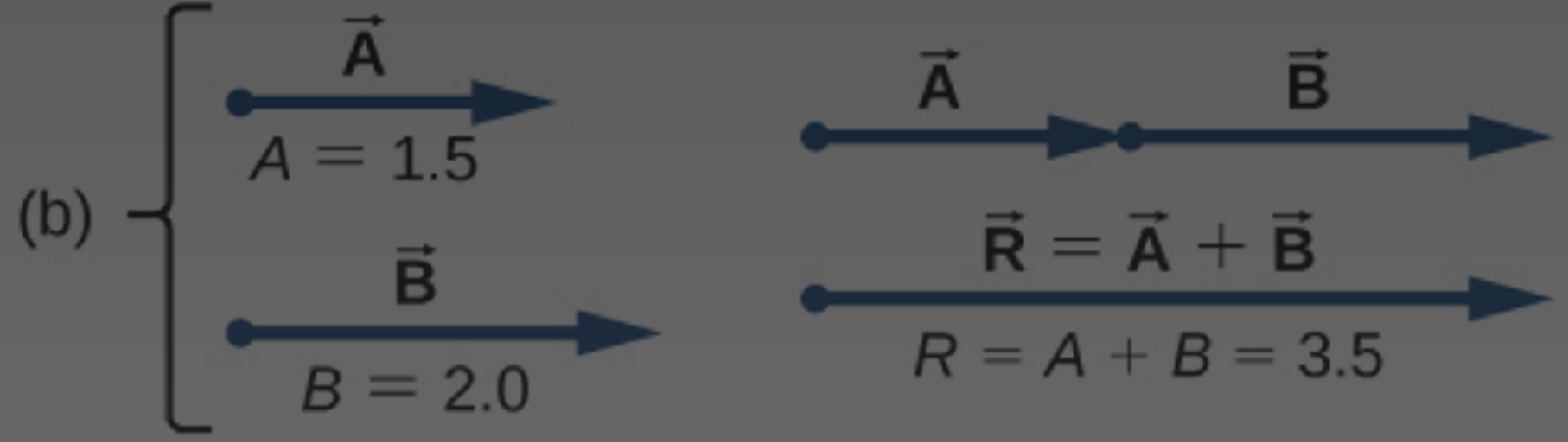
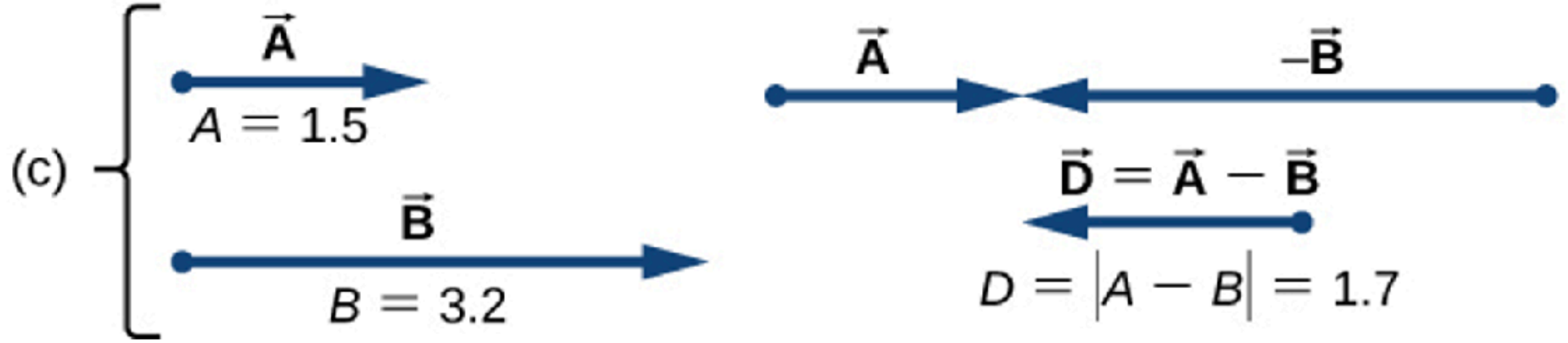
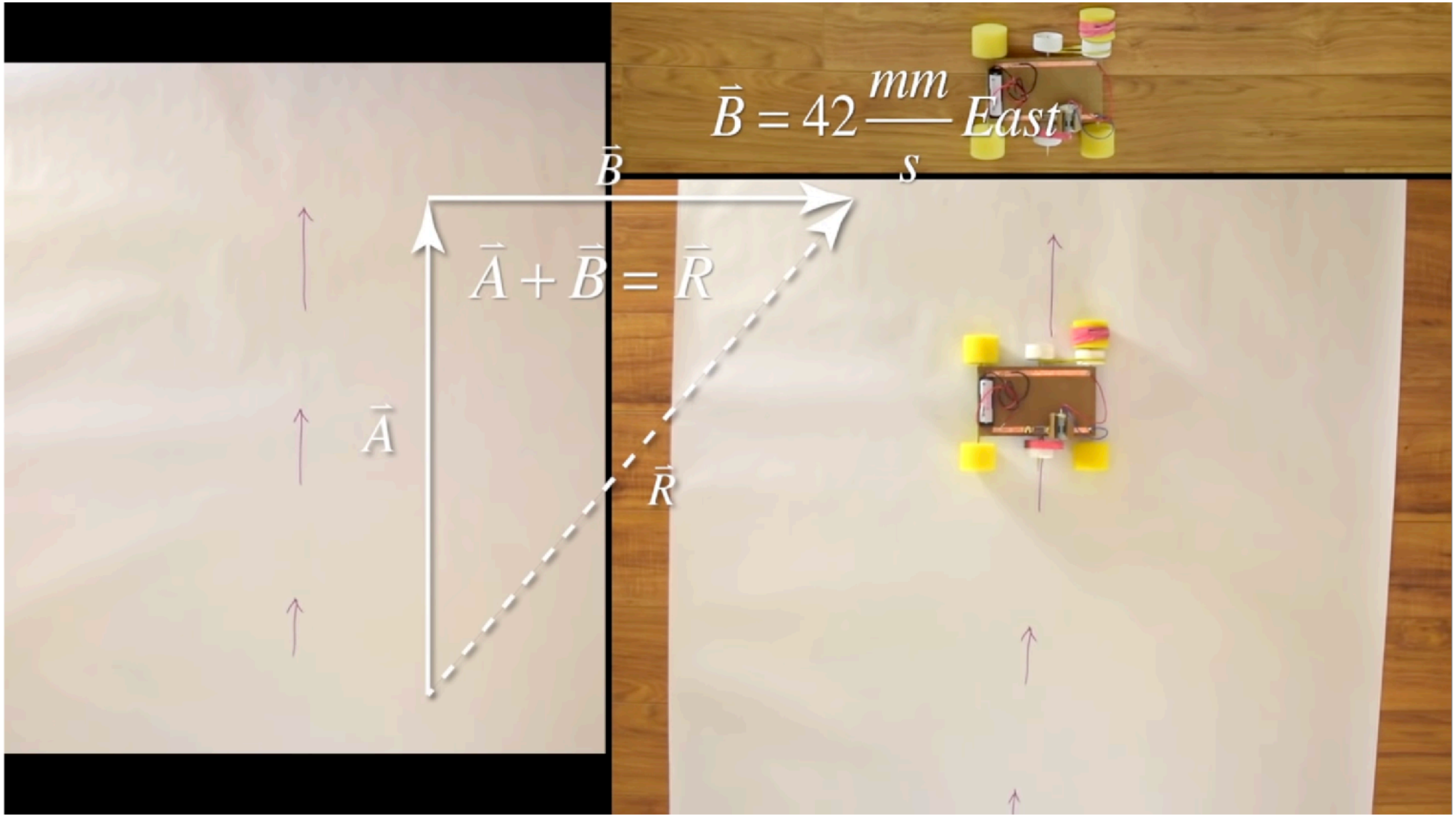


(c) Subtraction of two vectors

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

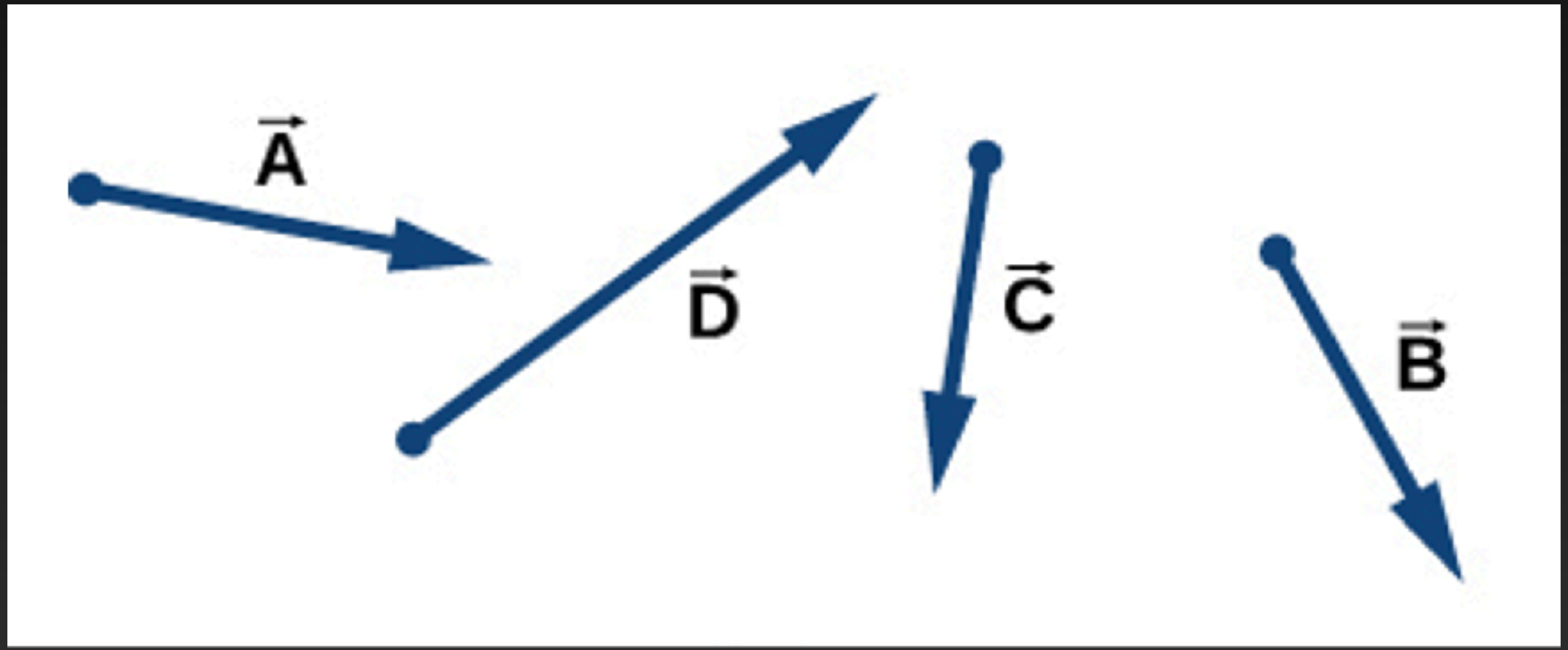


3. Introductory Tip-to-Tail Vector Addition Problem



Tail-to-head Method

Here are four vectors, with varying lengths and directions.



What is the resultant vector?

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

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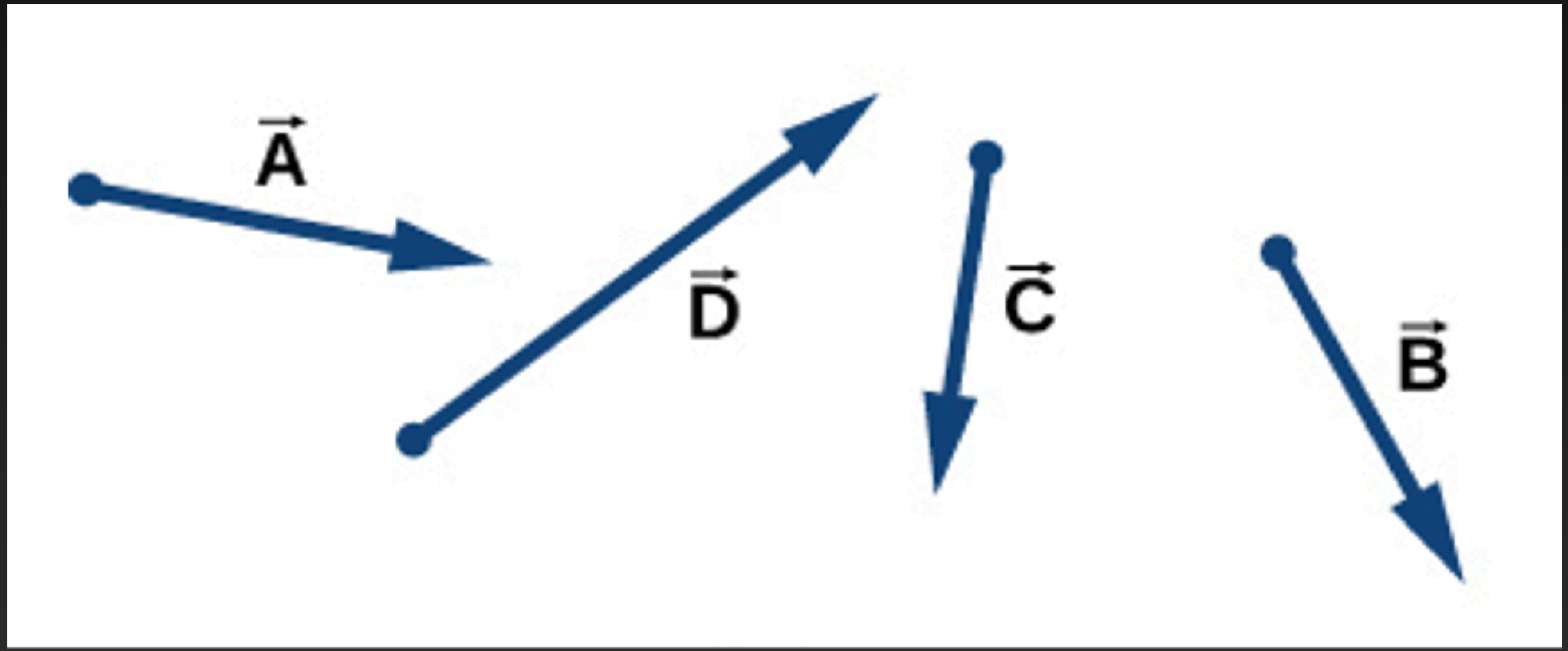

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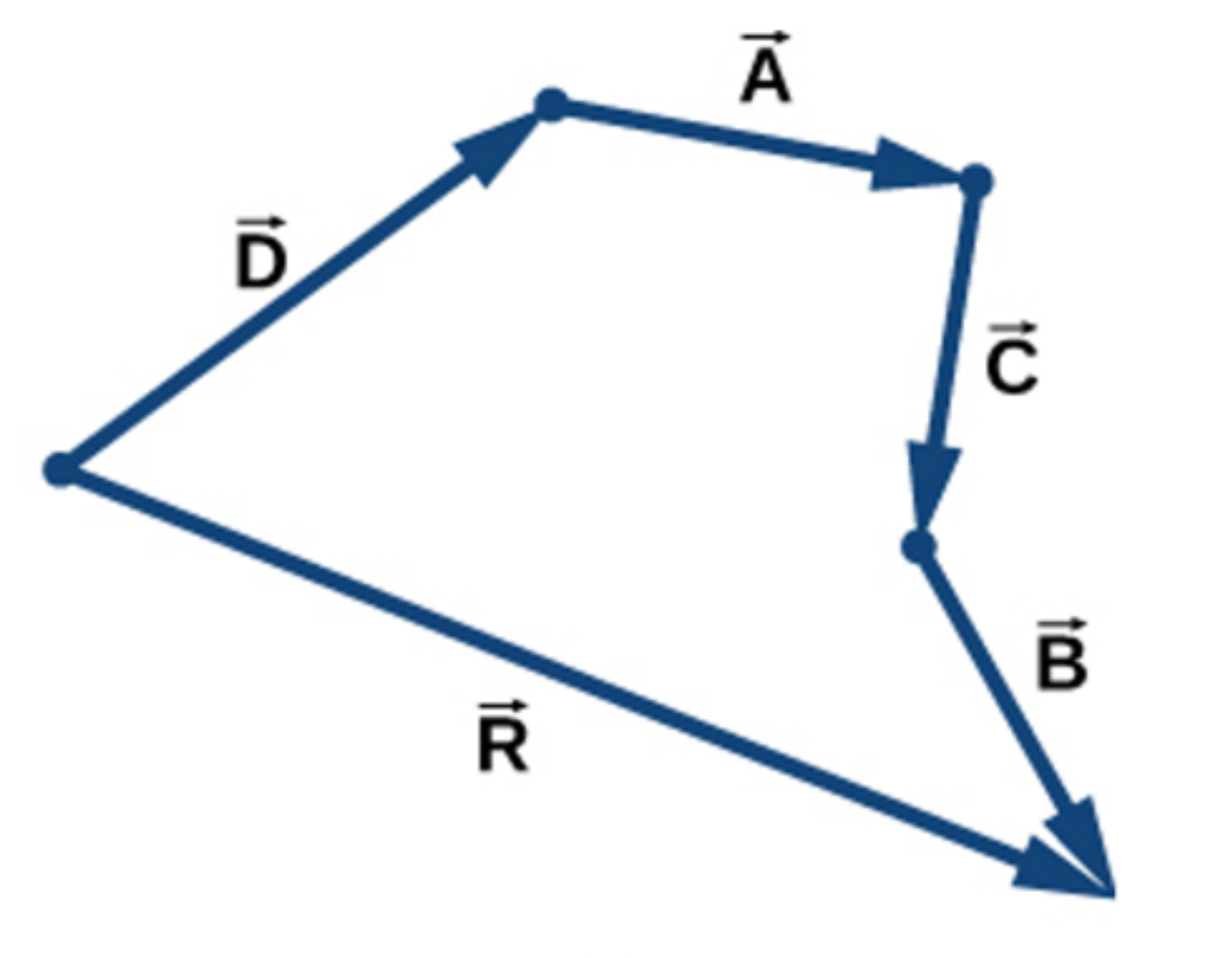
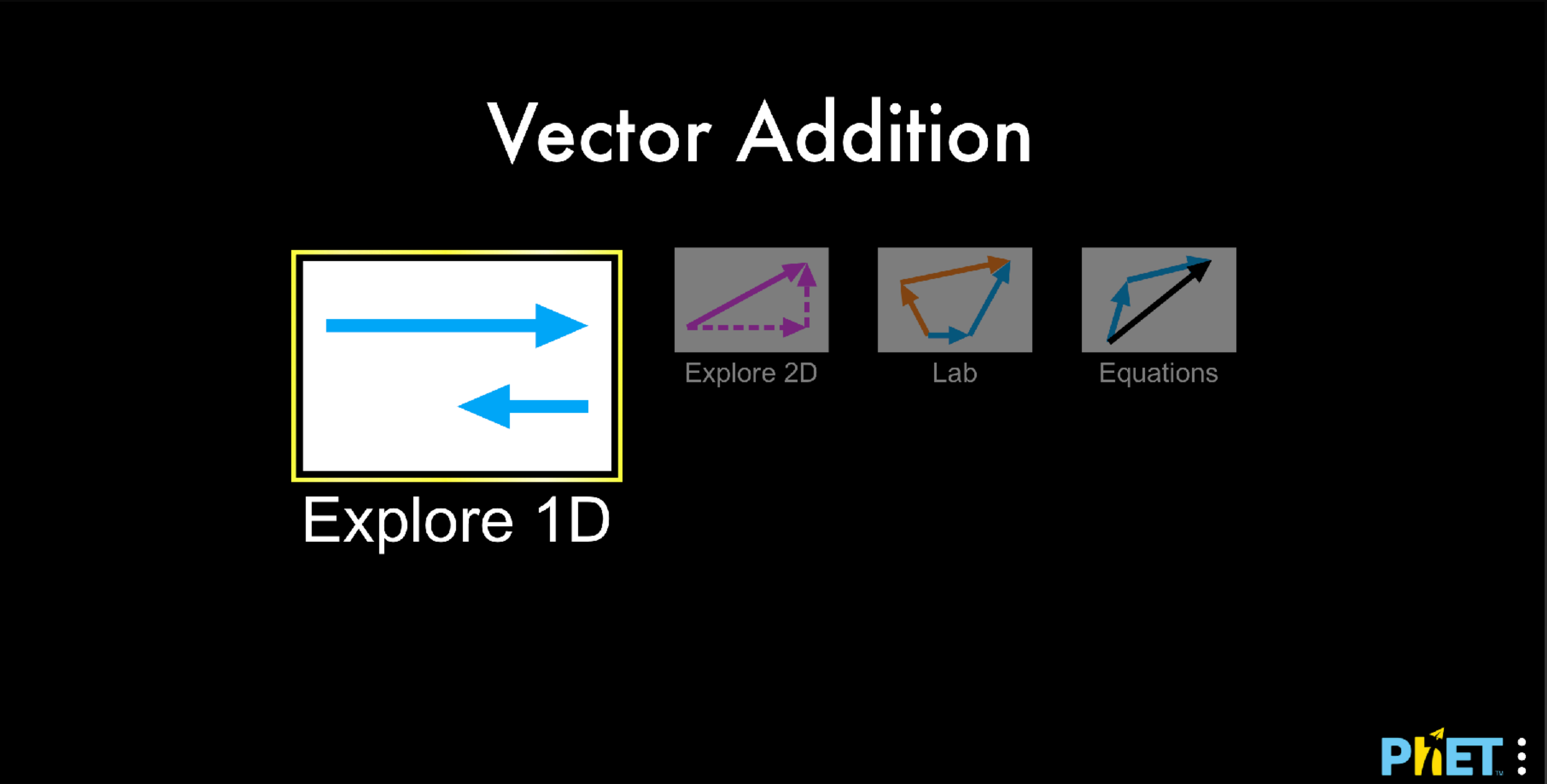
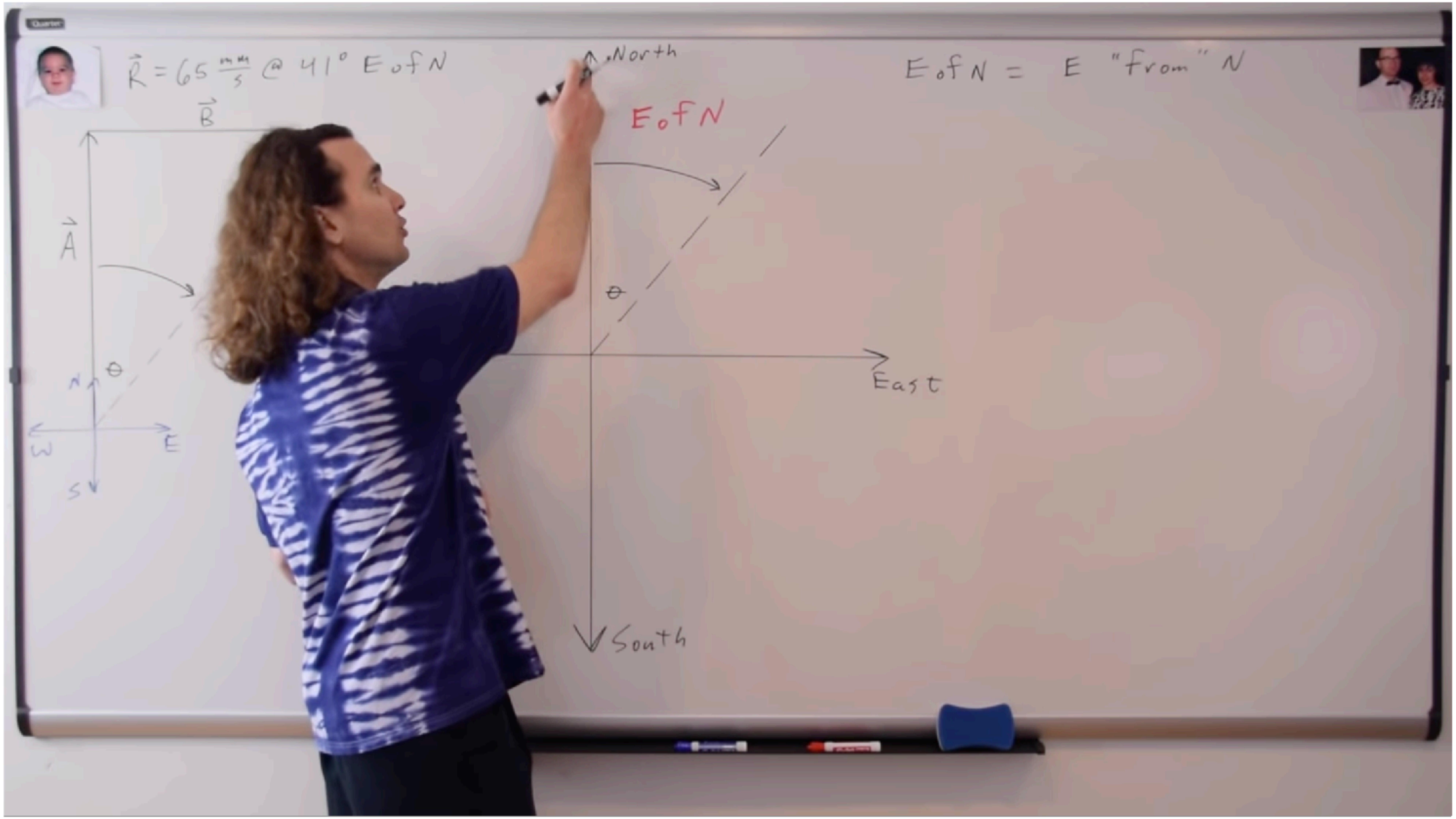



Vector Addition
Explore 1D
Explore 2D
Lab
Equations

5. How to use Cardinal Directions with Vectors



Clicker Questions

CQ.2.1

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.2.1

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✓ 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.2.2

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

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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

A ship sailing in the Gulf Stream is heading 25.0º west of north at a speed of 4.00 m/s relative to the water. Its velocity relative to the Earth is 4.80 m/s 5.00º west of north. What is the velocity of the Gulf Stream? (The velocity obtained is typical for the Gulf Stream a few hundred kilometers off the east coast of the United States.)

a) 8.67 m/s, 14.1° N of W

b) 1.72 m/s, 42.3° N of W

c) 1.72 m/s, 42.3° N of E

d) 8.80 m/s, 30.0° W of N

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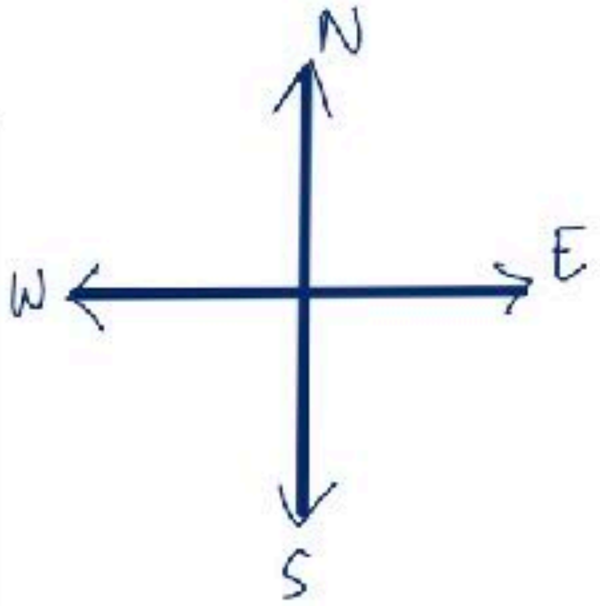
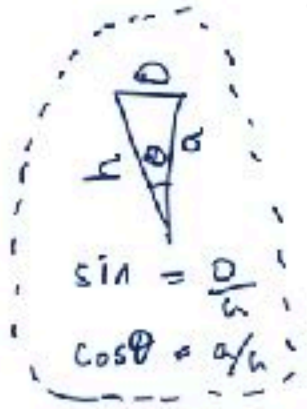
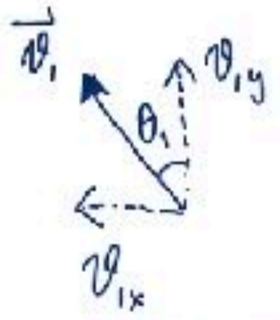


multiply by -1



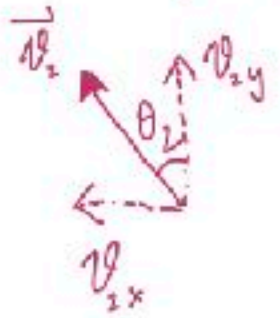
$\vec{v}_1 \rightarrow$ Velocity of ship relative to water : 4 m/s 25° W of N



$v_{1x} = |v_1|\sin\theta_1 =$

$v_{1y} = |v_1|\cos\theta_1 =$

$\vec{v}_2 \rightarrow$ Velocity of ship relative to Earth : 4.8 m/s 5° W of N



$v_{2x} = |v_2|\sin\theta_2 =$

$v_{2y} = |v_2|\cos\theta_2 =$

$\vec{v}_3 \rightarrow$ Velocity of water

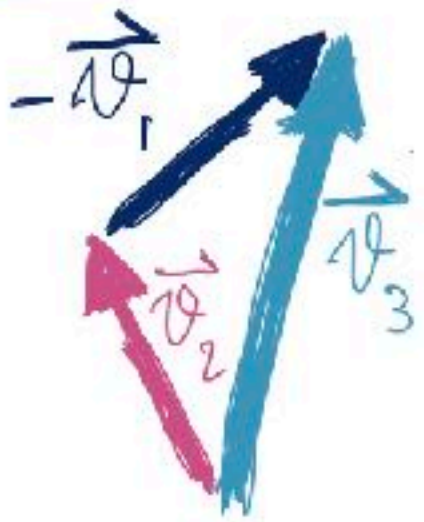
unknown!

The question is asking for the velocity of the water, given $\vec{v}_1$ and $\vec{v}_2$. One way to think about it, is that $\vec{v}_2$ is the resultant vector of the addition of $\vec{v}_1$ and $\vec{v}_3$

$$\vec{v}_2 = \vec{v}_1 + \vec{v}_3$$ $\rightarrow$ need to find!

$$\boxed{\vec{v}_3 = \vec{v}_2 - \vec{v}_1}$$

$$\boxed{\vec{v}_3 = \vec{v}_2 + (-\vec{v}_1)}$$



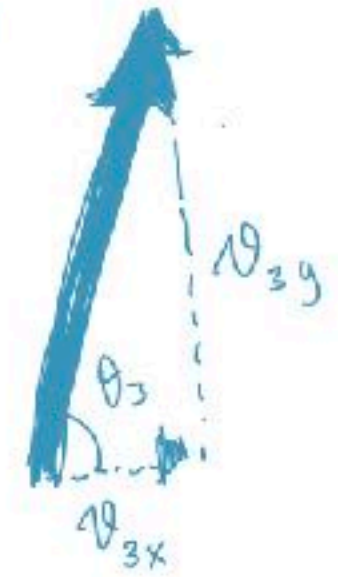
$$\vec{v}_3 = (v_{2x}\hat{i} + v_{2y}\hat{j}) - (v_{1x}\hat{i} + v_{1y}\hat{j})$$

$$= (v_{2x} - v_{1x})\hat{i} + (v_{2y} - v_{1y})\hat{j}$$

Magnitude

Direction

$$\boxed{\theta_3 = \tan^{-1}\left(\frac{v_{3y}}{v_{3x}}\right)}$$



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

Growth Mindset

Slides from University System of Georgia Centre for Teaching and Learning (GA-CTL). Link to original slides here.

Why Does Mindset Matter?

Designed by GA-CTL Workgroup: Crystal Edenfield
Rhonda Porter
Deborah Walker
Joyce Weinsheimer
Lisa Yount

What is mindset?

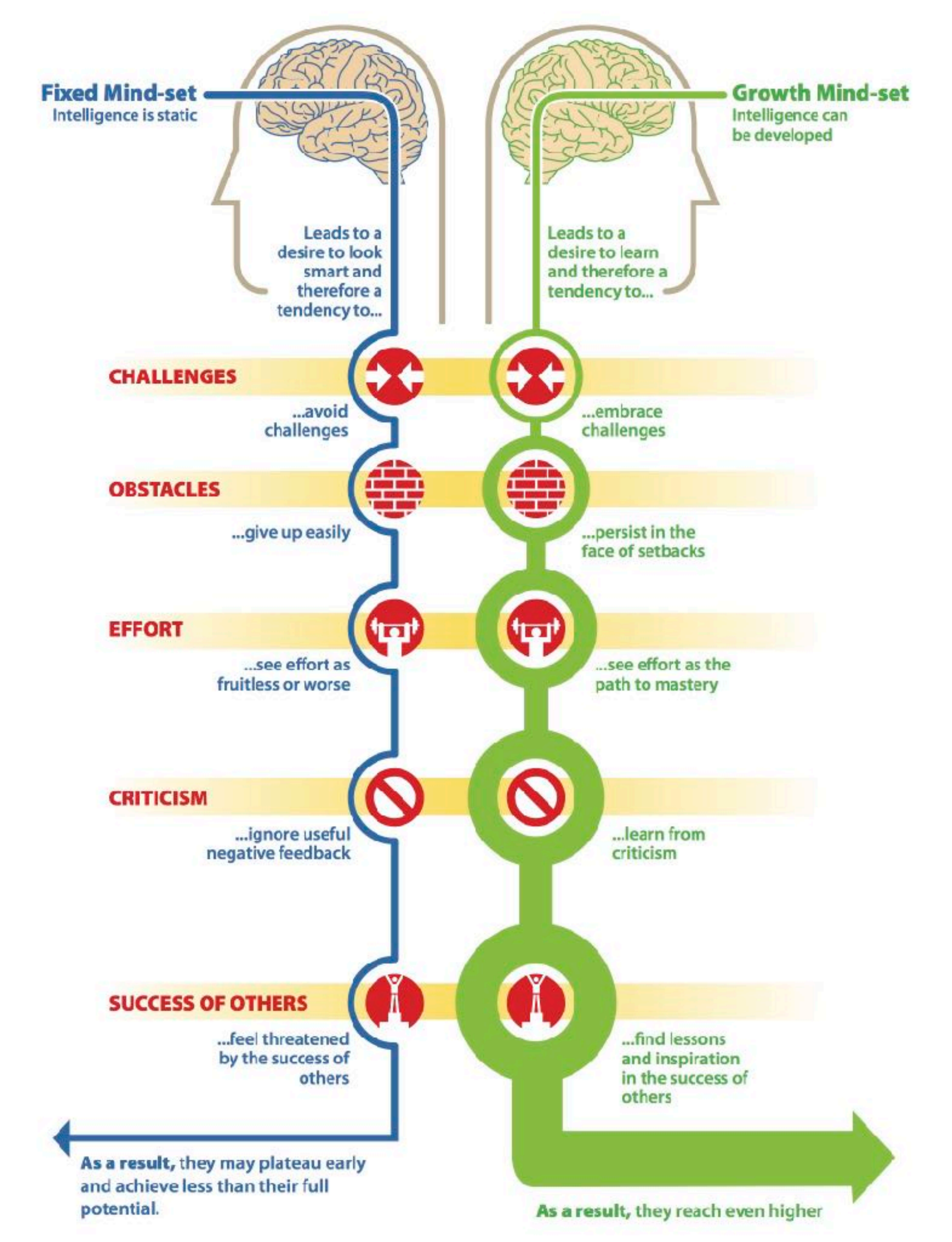
Mindsets are beliefs and perceptions about learning.

Fixed vs. Growth

- A fixed mindset is based on the belief that your qualities are carved in stone

- A growth mindset is based on the belief that your basic qualities are things you can cultivate through your **efforts**, your **strategies**, and **help from others**

Dweck, 2016



By Nigel Holmes based on the work of Carol Dweck

Why does mindset matter?

Resources

Books

- Dweck, C. (2016). Mindset: The new psychology of success. Penguin Random Hofuse, New York, New York.
- Major, C. H., Harris, M. S., & Zakrajsek, T. (2016). Teaching for learning: 101 intentionally designed educational activities to put students on the path to success. Taylor & Francis, New York, New York.
- McGuire, S. Y. (2015). Teach students how to learn: Strategies you can incorporate into any course to improve student metacognition, study skills, and motivation. Stylus Publishing, Sterling, Virginia.

Websites

- https://www.mindsetkit.org/topics/about-growth-mindset/what-is-growth-mindset
- http://mindsetscholarsnetwork.org/

Activity

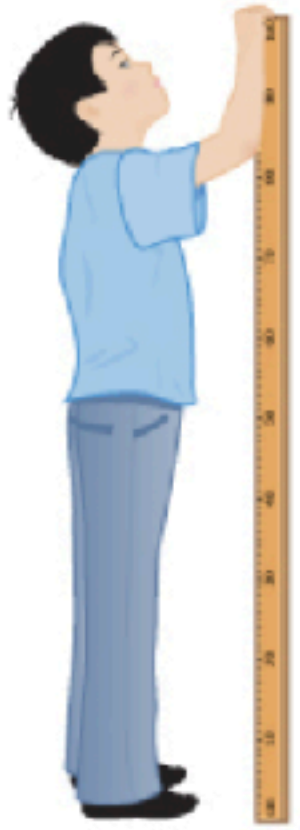
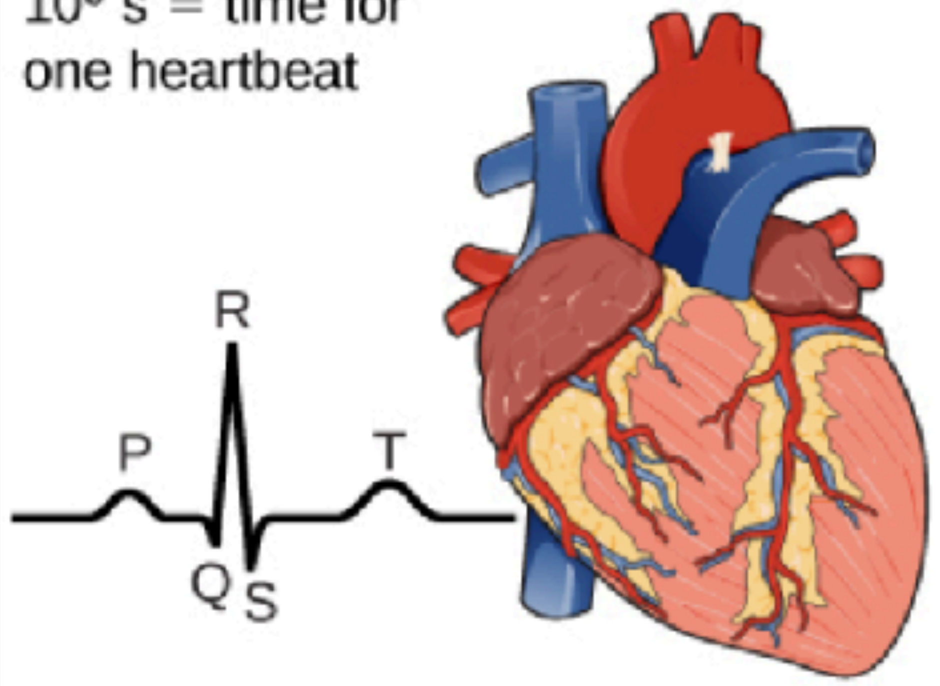
Length in Meters (m)	Masses in Kilograms (kg)	Time in Seconds (s)
$10^{[redacted]}$ m = diameter of proton	10^{-30} kg = mass of electron	10^{-22} s = mean lifetime of very unstable nucleus
10^{-14} m = diameter of large nucleus	$10^{[redacted]}$ kg = mass of proton	$10^{[redacted]}$ s = time for single floating-point operation in a supercomputer
10^{-10} m = diameter of hydrogen atom	$10^{[redacted]}$ kg = mass of bacterium	10^{-15} s = time for one oscillation of visible light
$10^{[redacted]}$ m = diameter of typical virus	$10^{[redacted]}$ kg = mass of mosquito	10^{-13} s = time for one vibration of an atom in a solid
10^{-2} m = pinky fingernail width	10^{-2} kg = mass of hummingbird	$10^{[redacted]}$ s = duration of a nerve impulse
10^{0} m = height of 4 year old child 	10^{0} kg = mass of liter of water 	10^{0} s = time for one heartbeat 
$10^{[redacted]}$ m = length of football field	10^{2} kg = mass of person	$10^{[redacted]}$ s = one day
$10^{[redacted]}$ m = diameter of Earth	$10^{[redacted]}$ kg = mass of atmosphere	$10^{[redacted]}$ s = one year
$10^{[redacted]}$ m = diameter of solar system	10^{22} kg = mass of Moon	$10^{[redacted]}$ s = human lifetime
10^{16} m = distance light travels in a year (one light-year)	$10^{[redacted]}$ kg = mass of Earth	$10^{[redacted]}$ s = recorded human history
$10^{[redacted]}$ m = Milky Way diameter	$10^{[redacted]}$ kg = mass of Sun	10^{17} s = age of Earth
10^{26} m = distance to edge of observable universe	10^{53} kg = upper limit on mass of known universe	$10^{[redacted]}$ s = age of the universe

Figure 1.4 This table shows the orders of magnitude of length, mass, and time.

Debrief

Length in Meters (m)	Masses in Kilograms (kg)	Time in Seconds (s)
10^{-15} m = diameter of proton	10^{-30} kg = mass of electron	10^{-22} s = mean lifetime of very unstable nucleus
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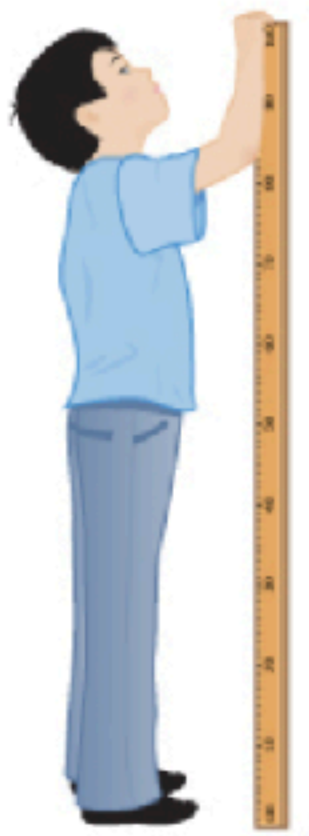
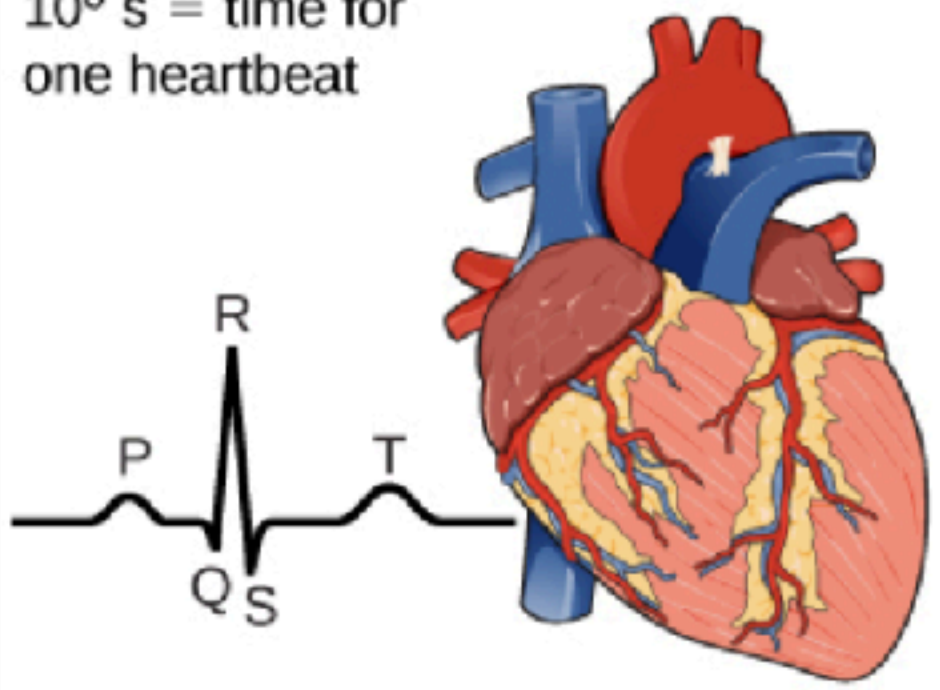
10^{0} m = height of 4 year old child 	10^{0} kg = mass of liter of water 	10^{0} s = time for one heartbeat 
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10^{13} m = diameter of solar system	10^{22} kg = mass of Moon	10^{9} s = human lifetime
10^{16} m = distance light travels in a year (one light-year)	10^{25} kg = mass of Earth	10^{11} s = recorded human history
10^{21} m = Milky Way diameter	10^{30} kg = mass of Sun	10^{17} s = age of Earth
10^{26} m = distance to edge of observable universe	10^{53} kg = upper limit on mass of known universe	10^{18} s = age of the universe

Figure 1.4 This table shows the orders of magnitude of length, mass, and time.

See you next class!