

Name _____ Mods _____

STUDY GUIDE

UNIT 6 - VECTORS

Date	Agenda	Homework
Tues 11/10	Conceptual Physics Video "Vectors and Projectiles" (notes on handout)	None
Wed 11/11	Introduce Vectors Activity: New York City Vectors (p. 14-16)	Read Sections 3.1-3.3 and take notes in packet (p. 1-2)
Thurs 11/12	Complete Activity: NYC Vectors	Watch Video 1 and take notes in packet (p. 3)
Fri 11/13	Vector problems-set 1 (p. 7-9)	Watch Video 2 and take notes in packet (p. 10)
Mon 11/17	Vector problems-set 2 (p. 11-12)	Review
Tues 11/18	Quest-vector	

CP Physics
Reading Notes
Section 3.1-3.3

1. In this chapter we will look at nonlinear motion or motion along a _____

2. This curve is a combination of
 - a. constant velocity _____
 - b. accelerated velocity _____
3. What happens horizontally _____ by what happens vertically
4. _____ are used to represent quantities that have both _____ and _____
5. A quantity that required both magnitude and direction for a complete description is called a _____
6. Velocity and acceleration are both _____
7. A quantity that is completely described by its magnitude is called a _____
8. Examples of scalar quantities are _____, _____, and _____
9. An _____ is used to represent the magnitude and direction of a _____
10. This arrow is called a _____
11. Draw and completely label Figure 3.2
12. List the simple 3 step technique used to find the resultant of a pair of vectors that are at right angles to each other
 - a.
 - b.
 - c.

13. Draw and Label Figure 3.4

14. Draw and Label Figure 3.5

15. Any vector drawn on a piece of paper can be resolved into _____ and _____ components

16. Draw and label Figure 3.6

VIDEO NOTES # 1 -VECTORS

Scalars and Vectors

There are a lot of different mathematical quantities used in physics. Examples of these include acceleration, velocity, speed, force, work, and power. These different quantities are often described as being either "scalar" or "vector" quantities. Below we will discuss what these words mean as well as introduce some basic vector math.

What is a scalar?

A scalar is a quantity that is fully described by a magnitude only. It is described by just a single number. Some examples of scalar quantities include speed, volume, mass, temperature, power, energy, and time.

What is a vector?

A vector is a quantity that has both a magnitude and a direction. Vector quantities are important in the study of motion. Some examples of vector quantities include force, velocity, acceleration, displacement, and momentum.

What is the difference between a scalar and vector?

A vector quantity has a direction and a magnitude, while a scalar has only a magnitude. You can tell if a quantity is a vector by whether or not it has a direction associated with it.

Example:

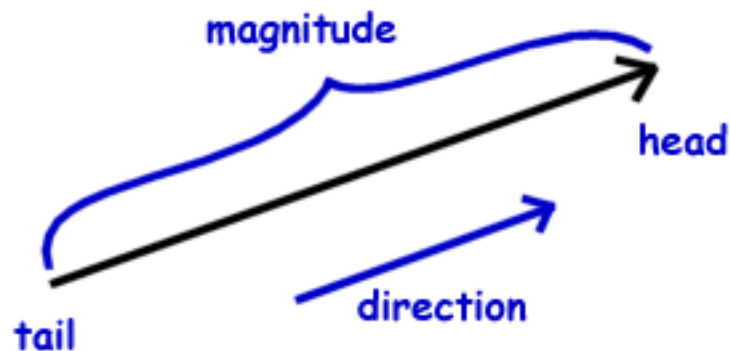
Speed is a scalar quantity, but velocity is a vector that specifies both a direction as well as a magnitude. The speed is the magnitude of the velocity. A car has a velocity of 40 mph east. It has a speed of 40 mph.

Identify the following as a scalar or vector quantity:

- 1) The football player was running 10 miles an hour towards the end zone.
- 2) The volume of that box at the west side of the building is 14 cubic feet.
- 3) The temperature of the room was 15 degrees Celsius.
- 4) The car accelerated north at a rate of 4 meters per second squared.

How to Draw a Vector

A vector is drawn as an arrow with a head and a tail. The magnitude of the vector is often described by the length of the arrow. The arrow points in the direction of the vector. See the picture below.



VECTORS, SCALARS, AND VECTOR ADDITION

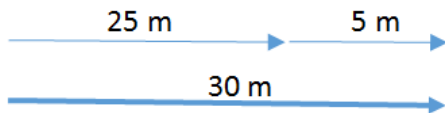
Define the following:

vector: a quantity with both magnitude and direction

scalar: a quantity with just magnitude

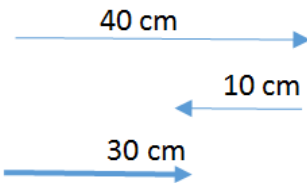
Vectors are represented by arrows. They can be added by placing the arrows head to tail. The arrows that extend from the tail of the first vector to the head of the last vector is called the resultant. It indicated both the magnitude and direction of the vector sum.

Example 1:



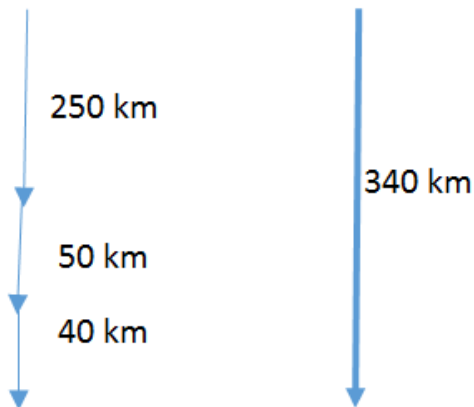
$$25 \text{ m east} + 5 \text{ m east} = 30 \text{ m east}$$

Example 2:



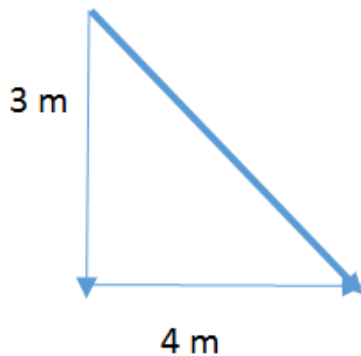
$$40 \text{ cm east} - 10 \text{ cm west} = 30 \text{ cm east}$$

Example 3:



$$250 \text{ km} + 50 \text{ km} + 40 \text{ km}$$

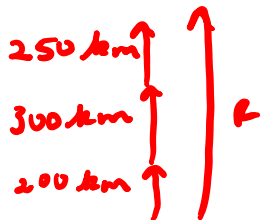
Example 4:



$$\begin{aligned} a^2 + b^2 &= c^2 \\ (3 \text{ m})^2 + (4 \text{ m})^2 &= c^2 \\ 9 \text{ m}^2 + 16 \text{ m}^2 &= c^2 \\ 25 \text{ m}^2 &= c^2 \\ c &= 5 \text{ m} \end{aligned}$$

Vector Problems - Set 1:

1. Every March, the swallows return to San Juan Capistrano, California after their winter in the south. If the swallows fly due north and cover 200 km on the first day, 300 km on the second day, and 250 km on the third day, draw a vector diagram of their trip and find their total displacement for the three day journey.



$$\begin{aligned} R &= 200 \text{ km} + 300 \text{ km} + 250 \text{ km} \\ R &= 750 \text{ km N} \end{aligned}$$

2. Some Antarctic explorers heading due south toward the pole travel 50. Km during the first day. A sudden snow storm slows their progress and they move only 30. Km on the second day. With plenty of rest they travel the final 65 km the last day and reach the pole. What was the explorers' displacement?



$$\begin{aligned} R &= 50 \text{ km} + 30 \text{ km} + 65 \text{ km} \\ R &= 145 \text{ km S} \end{aligned}$$

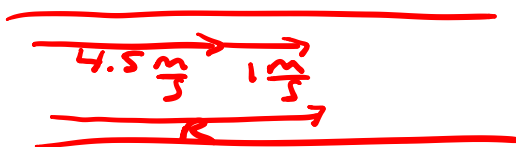
3. Rochelle is flying to New York for her big Broadway debut. If the plane heads out of Los Angeles with a velocity of 220. m/s in a north-east direction, relative to the ground, and encounters a wind blowing head-on at 45 m/s, what is the resultant velocity of the plane, relative to the ground?



$$R = 220 \frac{\text{m}}{\text{s}} - 45 \frac{\text{m}}{\text{s}}$$

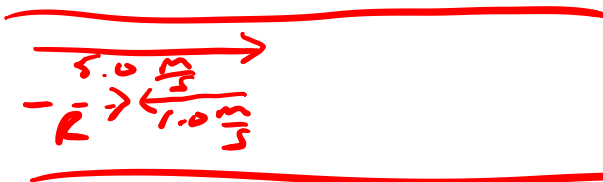
$$R = 175 \frac{\text{m}}{\text{s}} \text{ NE}$$

4. Eric is in a canoe and rows at a velocity 4.5 m/s due east on the river. If the current on that river is 1.0 m/s east, a) draw the vector diagram for this situation b) calculate his resultant velocity.



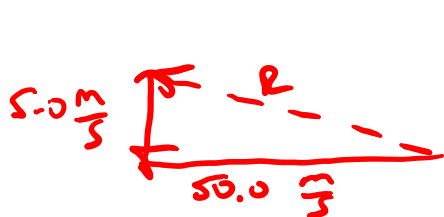
$$R = 4.5 \frac{\text{m}}{\text{s}} + 1.0 \frac{\text{m}}{\text{s}} = 5.5 \frac{\text{m}}{\text{s}} \text{ East}$$

5. Michael is in a canoe and rows at a velocity of 5.0 m/s due east. If the current on that river is 1.0 m/s west, a) draw the vector diagram for the situation and b) calculate his resultant velocity.



$$R = 5.0 \frac{\text{m}}{\text{s}} - 1.0 \frac{\text{m}}{\text{s}} = 4.0 \frac{\text{m}}{\text{s}} \text{ East}$$

6. If St. Louis Cardinals homerun king, Mark McGwire, hit a baseball due west with a speed of 50.0 m/s and the ball encountered a wind that blew it north at 5.0 m/s, a) draw the vector diagram for the situation and b) calculate the resultant velocity.



$$a^2 + b^2 = c^2$$

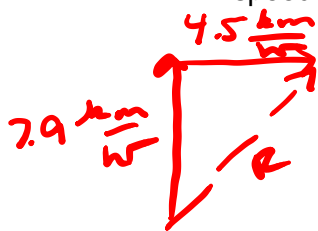
$$(50.0 \frac{m}{s})^2 + (5.0 \frac{m}{s})^2 = c^2$$

$$2500 + 25 = c^2$$

$$2525 = R^2$$

$$R = 50.2 \frac{m}{s} \text{ NW}$$

7. Indiana Jones is trying to cross a raging river in a small motor boat to escape some natives who have decided to invite him to dinner (as the main course). Indy gets into the boat, starts up the engine, and sails due NORTH directly across the river at a speed of 7.9 km/hr. If the current of the river is due EAST at 4.5 km/hr, what will be the actual speed and direction of Indiana's boat (with respect to the shore)?



$$a^2 + b^2 = c^2$$

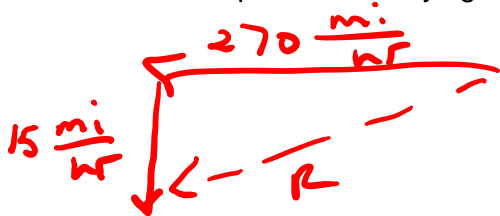
$$(7.9 \frac{km}{hr})^2 + (4.5 \frac{km}{hr})^2 = R^2$$

$$62.41 + 20.25 = R^2$$

$$82.66 = R^2$$

$$R = 9.1 \frac{km}{hr} \text{ NE}$$

8. James Bond is flying a jet, on route to Vulgaria where Miss Money Penny is being held captive by the evil Baron Bomburst. He is flying at 270 mph due WEST when he gets a radio message telling him that the wind is blowing due SOUTH at a speed of 15 mph. Help James out by figuring out his true speed and direction.



$$a^2 + b^2 = c^2$$

$$(270 \frac{mi}{hr})^2 + (15 \frac{mi}{hr})^2 = R^2$$

$$72,900 + 225 = R^2$$

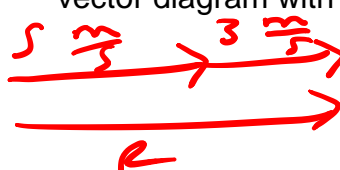
$$73,125 \frac{mi}{hr} = R^2$$

$$R = 270.4 \frac{mi}{hr} \text{ SW}$$

VIDEO NOTES # 2 -VECTORS

Vector Problems - Set 2: River Vector Problem Worksheet

1. A man in a kayak can paddle at 5 m/s. If he travels downstream in a current of 3 m/s for 5 minutes, how fast is he moving and how far did he travel? Include a vector diagram with your answer.



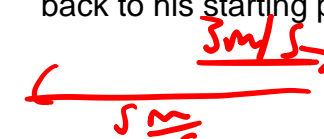
$$R = 5 \frac{m}{s} + 3 \frac{m}{s} = 8 \frac{m}{s}$$

$$v = 8 \frac{m}{s}$$

$$t = 5 \text{ min} \cdot \frac{60 \text{ s}}{1 \text{ min}} = 300 \text{ s}$$

$$d = v \cdot t = (8 \frac{m}{s})(300 \text{ s}) = 2400 \text{ m}$$

2. The man then turns around and heads upstream. How long would it take to get back to his starting point?



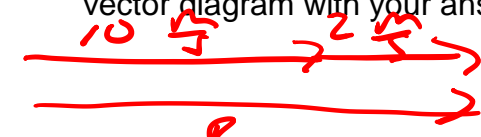
$$R = 5 \frac{m}{s} - 3 \frac{m}{s} = 2 \frac{m}{s}$$

$$d = 2400 \text{ m}$$

$$v = 2 \frac{m}{s}$$

$$t = \frac{d}{v} = \frac{2400 \text{ m}}{2 \frac{m}{s}} = 1200 \text{ s}$$

3. A man in a kayak can paddle at 10 m/s. If he travels downstream in a current of 2 m/s for 10 minutes, how fast is he moving and how far did he travel? Include a vector diagram with your answer.



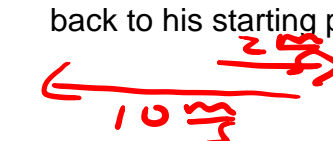
$$R = 10 \frac{m}{s} + 2 \frac{m}{s} = 12 \frac{m}{s}$$

$$v = 12 \frac{m}{s}$$

$$t = 10 \text{ min} \cdot \frac{60 \text{ s}}{1 \text{ min}} = 600 \text{ s}$$

$$d = v \cdot t = (12 \frac{m}{s})(600 \text{ s}) = 7200 \text{ m}$$

4. The man then turns around and heads upstream. How long would it take to get back to his starting point?



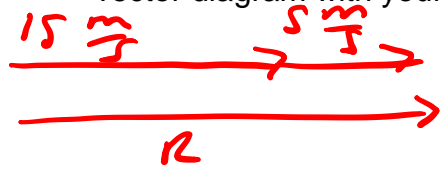
$$R = 10 \frac{m}{s} - 2 \frac{m}{s} = 8 \frac{m}{s}$$

$$d = 7200 \text{ m}$$

$$v = 8 \frac{m}{s}$$

$$t = \frac{d}{v} = \frac{7200 \text{ m}}{8 \frac{m}{s}} = 900 \text{ s}$$

5. A man in a kayak can paddle at 15 m/s. If he travels downstream in a current of 5 m/s for 20 minutes, how fast is he moving and how far did he travel? Include a vector diagram with your answer.



$$R = 15 \frac{m}{s} + 5 \frac{m}{s}$$

$$= 20 \frac{m}{s}$$

$$v = 20 \frac{m}{s}$$

$$t = 20 \text{ min} \cdot \frac{60 s}{1 \text{ min}} = 1200 s$$

$$v = \frac{d}{t}$$

$$d = v \cdot t$$

$$= \left(20 \frac{m}{s}\right)(1200 s) = \boxed{24,000 \text{ m}}$$

6. The man then turns around and heads upstream. How long would it take to get back to his starting point?



$$R = 15 \frac{m}{s} - 5 \frac{m}{s}$$

$$= 10 \frac{m}{s}$$

$$v = 10 \frac{m}{s}$$

$$d = 24,000 \text{ m}$$

$$t = \frac{d}{v} = \frac{24,000 \text{ m}}{10 \frac{m}{s}}$$

$$t = 2,400 \text{ s}$$

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Name _____ Date _____

INTRODUCTION TO VECTORS NEW YORK CITY TRIP

This activity will use vectors to map a trip around New York City.

Draw vectors on your map from point to point along the trip through NYC in different colors.

North Vectors-Red
East Vectors-Green

South Vectors-Blue
West Vectors-Yellow

Site	Address
Penn Station	33 rd St and 7th Ave
Empire State Building	34th St and 5th Ave NY
NY Library	41st and 5th Ave
Grand Central Station	43rd and Park Ave (same as 4th Ave)
UN Headquarters	45th and 1st Ave
Rockefeller Center	49th and 6th Ave
Carnegie Hall	57th and 7th Ave
Lincoln Center	65th St and 10th Ave
Javits Center	36th St and 11th Ave

Add all the north vectors together:

Add all the south vectors together:

Add all the East vectors together:

Add all the West vectors together:

Subtract your North and South vectors and determine the resultant vector:

Subtract the East and West vectors and determine the resultant vector:

Draw new vectors to determine the resultant vector on the map (in purple) and determine the resultant vector quantity:

Compare the two resultant vectors:

