PHYSICS

ADDING VECTORS IN 2-D (At an Angle)

Learning Goals

B2.5 - Solve problems involving distance, position, and displacement using a vector diagram.

B3.2 - Distinguish between scalar and vector quantities as they relate to uniform and non-uniform motion.

Success Criteria

- ☐ What is a displacement vector?
- ☐ What is the rule for adding Vectors?
- ☐ When solving algebraically, why is it important to define which direction is positive?
- ☐ Can you draw a vector diagram to illustrate solving vectors in 2D
- ☐ Are you able to use Pythagorean Theorem and Primary Trig Ratios to calculate Resultant Displacement?
- ☐ Are you able to use Sine Law and Cosine Law to calculate Resultant Displacement?

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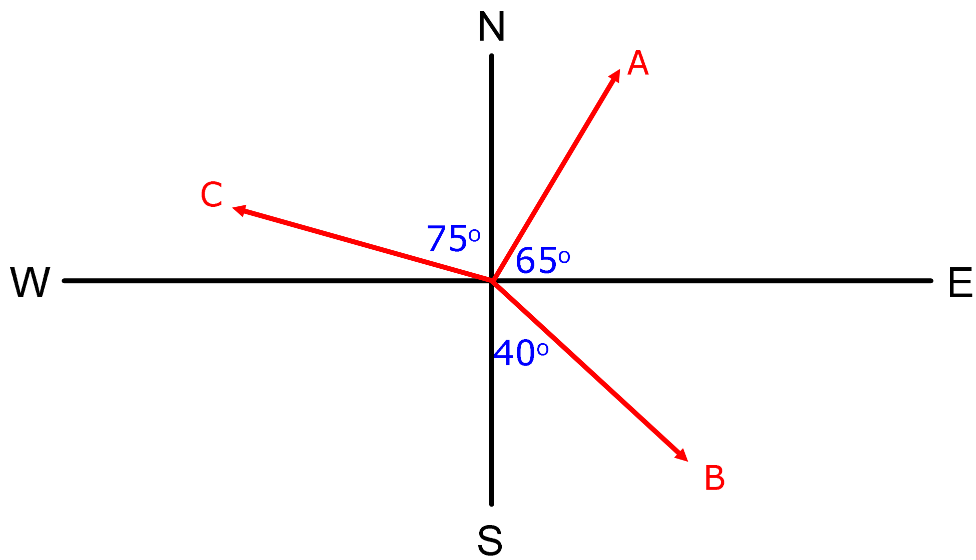
Not all vectors lie along the N,S,E,W lines. Some vectors are at and angle between these compass lines. ***Ex [N20°E]***



NOTE: North and South are the "Primary Directions". All directions should start with either North or South.

Ex: [N20°E] is preferred to [E70°N]

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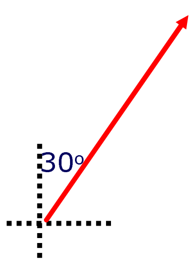
Reducing an Angled Vector into its Components

In order to add angled vectors we will break them down into their more familiar components with trigonometry.

Ex: Reduce the vector 10 km [N30°E] into its components.



Now that the vector has been reduced, we can add them up like we did in previous lessons.

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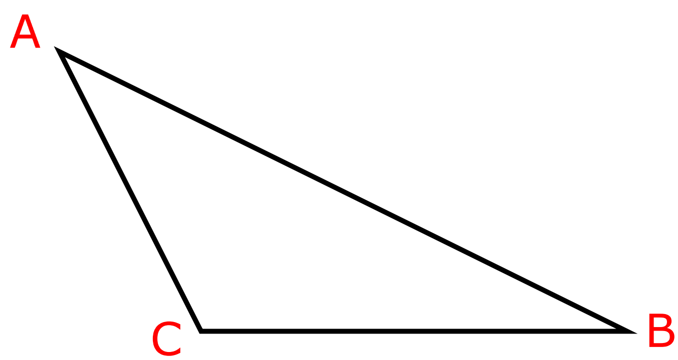
Sine and Cosine Law

In order to add angled vectors that will produce a non-right angled triangle, we can use Sine and Cosine Law

Recall:



Find c and A in the above triangle given the following conditions:

a = 10
b = 20
C = 120°

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Ex: A person walks 5 km [E] then turns to walk 15 km [N40°E]. Find the resultant displacement.

Ex: A person walks 20 km [S35°W] then turns to walk 10 km [N15°W]. Find the resultant displacement.

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HOMEWORK

ADDING VECTORS in 2D

1. One day, Erica and her sister leave from the dock in front of their cottage and travel 0.65 km [E] and then 0.45 km [S] where they stop by a big rock surrounded by water. What was their resultant displacement?

2. Mr. Caslick's physics class is going to Cedar Point for a day of physics fun. To get there, they travelled 205 km [S] to the 401 and then 56 km [W] and finally, 22 km [N]. What was their resultant displacement?

3. One day, the Vice Principal was walking around the school looking for potential troublemakers. She walks 30 m [W] down the math hallway, 40 m [N] and passes by the office on her way towards the library. Then she makes a right and walks 20 m [E] towards the gym. What is her resultant displacement?

4. Shawn and Aliesha are hiking with their geography class. They hike, 550 m [W], then 630 m [W 40° N]. What is their resultant displacement?

5. An airplane, on its way to Mexico for March break, flies 2000 km due South and then turns and flies another 1750 km [S 30° W] in 4 hours.

a. What is the distance travelled?

b. What is the resultant displacement?

c. What is the speed of the plane?

d. What is the velocity of the plane?

1.7 - Adding Vectors in 2-D (Angles)

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HOMEWORK

Vector Addition Worksheet

Consider the following vectors

$\vec{A}$=7.0 m [E], $\vec{B}$=15 .0 m [N] , $\vec{C}$ = 11.0 m [E], $\vec{D}$= 10.0 m [S], $\vec{E}$ = 6.0 m [W], $\vec{F} = 8.0\ m\ [N30.0^0 E]$

1. What is $\vec{A} + \vec{C}$?

2. What is $\vec{B} + \vec{D}$?

3. What is $\vec{A} + \vec{B}$

4. What is $|\vec{A} + \vec{B}|$

5. What is $\vec{D}\ +\ \vec{E}$?

6. What is $\vec{A} + \vec{B} + \vec{C} + \vec{D} + \vec{E}$

7. What is $\vec{B} + \vec{F}$

8. A plane is flying from Physicsville airport to Kinematics town which is located 81 km due south of Physicsville. While flying over Kinematics town the pilot receives a message instructing her to land at an airport in "Newtonville" which is 42 km [W] of Kinematics town. Her average ground speed is 1.5×10^2 km/h

i) What is the total distance for her entire trip?
ii) How long did the trip take?
iii)What is her total displacement for the entire trip?
iv) What is her average velocity for the entire trip?

Answers

1.	18.0 m [E]	2.	5.0 m [N]	3.	16.6 m [E 65.0^{o}N]	4.	16.6 m
5.	11.7 m [W 59^{o}S]	6.	13.0 km [E 22.6^{o}N]	7.	20.2 m [N 23.3^o E]		
8.	123 km	ii) 0.82 h or 49 min	iii) 91 km [W 62.6^o S]				
	iv) 1.1 x10^2km/h[W 62.6^o S]						

1.7 - Adding Vectors in 2-D (Angles)

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HOMEWORK

1. An ant travels 2.78 cm [W] and then turns and travels 6.25 cm [S 40° E]. What is the ant's total displacement? T/I [ans: 4.94 cm [E 76° S]]
2. A paper airplane flies 2.64 m [W 26° N] and then is caught by the wind, which causes it to travel 3.21 m [S 12° E]. What is the paper airplane's total displacement? T/I [ans: 2.62 m [W 49° S]]
3. A football player runs 11 m [N 20° E]. He then changes direction and runs 9.0 m [E]. What is his total displacement? T/I
4. What is the total displacement for a boat that sails 200.0 m [S 25° W] and then tacks (changes course) and sails 150.0 m [N 30° E]? T/I
5. Determine the total displacement of an object that travels 25 m [N 20° W] and then 35 m [S 15° E]. T/I

3. 16 m [N 51° E]
4. 52.23 m [S 11° W]
5. 1.0 × 10 m [S 3° E]

7. **Add the following displacement vectors.**

$$\Delta\vec{d}_1 = 25\text{ m [N }30^\circ\text{ W]},\ \Delta\vec{d}_2 = 30.0\text{ m [N }40^\circ\text{ E]},$$
$$\Delta\vec{d}_3 = 35\text{ m [S }25^\circ\text{ W]}$$

7. 15 m [N 32° W]

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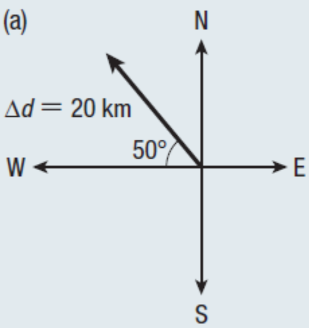
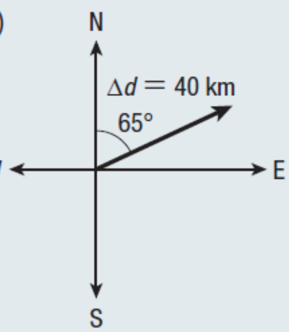
1. Break each vector down into an *x*-component and a *y*-component. T/I

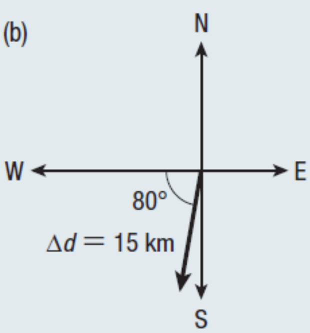
(a)



(c)



(b)



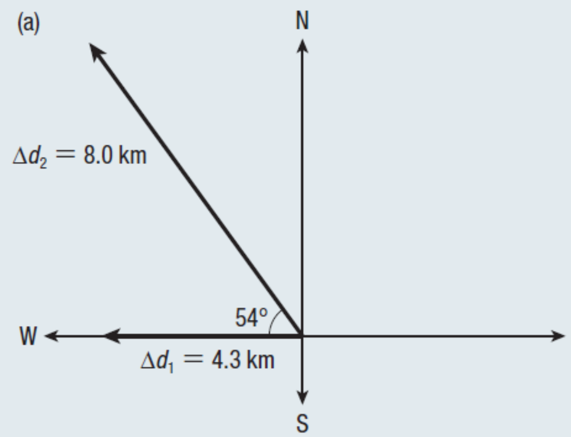
7. Use the component method to add the following displacement vectors. T/I

$\Delta\vec{d}_1 = 25$ m [N 30° W], $\Delta\vec{d}_2 = 30.0$ m [N 40° E],

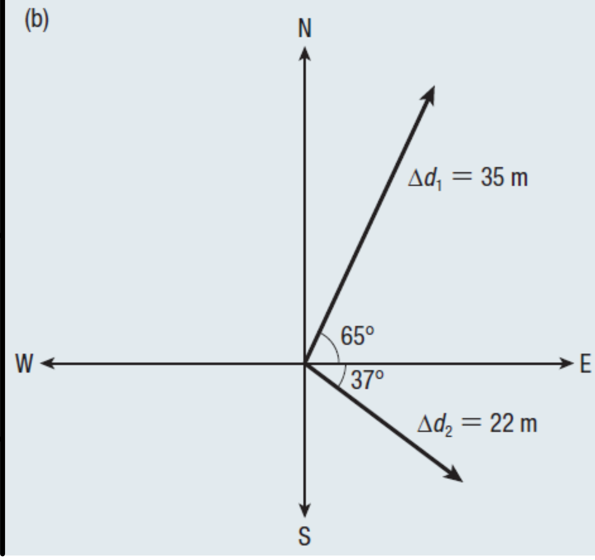
$\Delta\vec{d}_3 = 35$ m [S 25° W]

6. Use the component method to determine the total displacement given by the two vectors shown in each diagram.

(a)



(b)



1. (a) 13 km [W], 15 km [N]
   (b) 2.6 km [W], 15 km [S]
   (c) 36 km [E], 17 km [N]
6. (a) 11 km [W 36° N]
   (b) 37 m [E 30° N]
7. 15 m [N 32° W]