**Map of the USA**

**Exploring the Addition and Subtraction of Vectors**

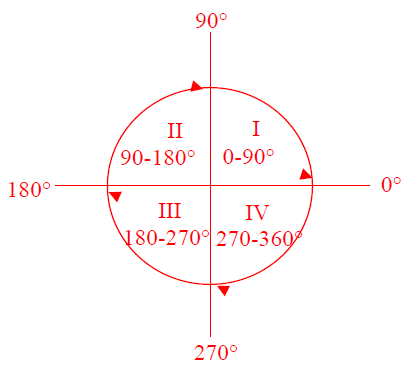
The information below describes a series of flights taken by a pilot. In Part I you will draw, as

precisely as possible, the displacement vectors of this flight on your map. In Part II, you will use

the same map to draw several velocity vectors on the map and determine the airplane’s velocity.

You should first draw and label your vectors in pencil. After you complete the preliminary work,

trace all of your vectors and label the magnitudes and angles in marker so that they are clearly

visible.

Longitude and latitude lines are not shown on the map, and directions and distances will not be absolutely correct because of the curvature of the earth.

**PURPOSE**

You will use a map of the USA to study the addition and subtraction of vectors. The more careful you are in measuring the angles and the displacements, the better your results will be.

**PART I: DISPLACEMENT**

In each of the following steps, calculate the displacement of the airplane and draw the appropriate displacement vector on the map provided by your teacher. Be sure to add each vector “head-to-tail” to the vector that precedes it.

1. Starting from DFW (Dallas-Fort Worth) airport, an airplane flies at a heading of 36o at a speed of 420 km/hr for 1.25 hours.
2. After visiting the Clinton Library, the airplane travels 480 km at a heading of 352o. As the pilot approaches to land, he sees the Vulcan statue.
3. Next the airplane travels at a speed of 625 kilometers per hour for 45 minutes at a heading of 76o. After the pilot lands, he pays homage to the likes of Secretariat, Seattle Slew, Affirmed and 8 others before returning to his trip.
4. Next, the plane travels 570 km at a heading of 6o. While taking a break, the pilot visits a state capitol building designed by Thomas Jefferson and enjoys the city which was once the home of Pocahontas.
5. After enjoying a nice ham dinner, the plane flies at 410 km/hr for 1.3 hours at a heading of 55o. The pilot enjoys a nice aerial view of Yale University and stops to refuel before continuing his trip.
6. After resting and refueling, the plane proceeds 130 km at 69o. The pilot decides to spend the night and enjoys a fantastic dinner of lobster and clams before beginning a long westward flight.
7. This last destination before returning home is 3770 km at 175o. After landing the pilot takes the MAX light rail to visit his friends at Vernier Scientific and Software in nearby Beaverton. After visiting the Vernier Solar Energy Demonstration Project, the pilot returns to his hotel to contemplate his trip and plan a return home to Dallas, Texas.

**PART I: DISPLACEMENT Questions**

1. What is the distance traveled by the airplane in the first leg of the trip?
2. At the end of each leg the pilot lands at the nearest airport. What is the name of the town

nearest to the airport at the end of the second leg?

1. What is the total distance flown for the entire trip before returning from Portland?
2. After the 7 legs of the trip, what is the total displacement from DFW airport? (both magnitude and direction in degrees) Draw this vector on your map.
3. Between what two states does the Mississippi run where the plane crosses the river?
4. What is the name of the city or town nearest to the airport when the plane lands at its eastern most point?

**PART II: VELOCITY**

Use the same map, but use a different colored marker to distinguish between the vectors in

Part I and Part II. Use the same scale as in Part I. Draw the appropriate vectors indicated.

After returning to his hotel near the Willamette River the pilot takes out his map and

contemplates his trip and his anticipated return home.

1. Construct the resultant of all the legs of the trip which resulted in the pilots visit to

Portland, Oregon.

1. The equilibrant is a vector equal in magnitude and opposite in direction to the resultant.

Reverse the direction of the resultant by placing an arrow on the head end of the resultant. This now represents the desired ground speed vector the plane must achieve to return to Dallas Love Field.

1. The pilot wishes to depart the next morning from the airport in Portland, Oregon, and fly to the airport nearest downtown Dallas (Love Field). The pilot wishes to make this trip in 4.5 hours. There is a constant wind of 55 Kilometers per hour blowing N 90° (due north or from the south). How far will the wind travel during this 4.5 hour trip? Draw a wind

vector starting this distance south of Dallas and ending at Love Field. This represents your wind speed vector.

1. Now draw a vector from Portland to the tail of the wind speed vector. This represents the

plane’s required air speed vector. The resultant of the plane’s air speed vector and the

wind speed vector gives the plane’s ground speed vector.

1. Label these vectors on your map.

**PART II: VELOCITY Questions**

1. What is the bearing (in degrees) for the vector between the airport at Portland, Oregon and the airport Dallas Love Field?
2. How far is the pilot from Dallas, Texas?
3. The pilot wishes to depart the next morning from the airport in Portland, Oregon, and fly to the airport nearest downtown Dallas (Love Field). The pilot wishes to make this trip in 4.5 hours. There is a constant wind of 55 kilometers per hour blowing due north (from the

south). What air speed in kilometers per hour and what direction (in degrees) must the pilot maintain in order to complete the trip in 4.5 hours?

1. Indicate and label all three vectors (air, wind and ground) on your map. Indicate both the

magnitude (in km/h) and direction (in degrees) of each vector.