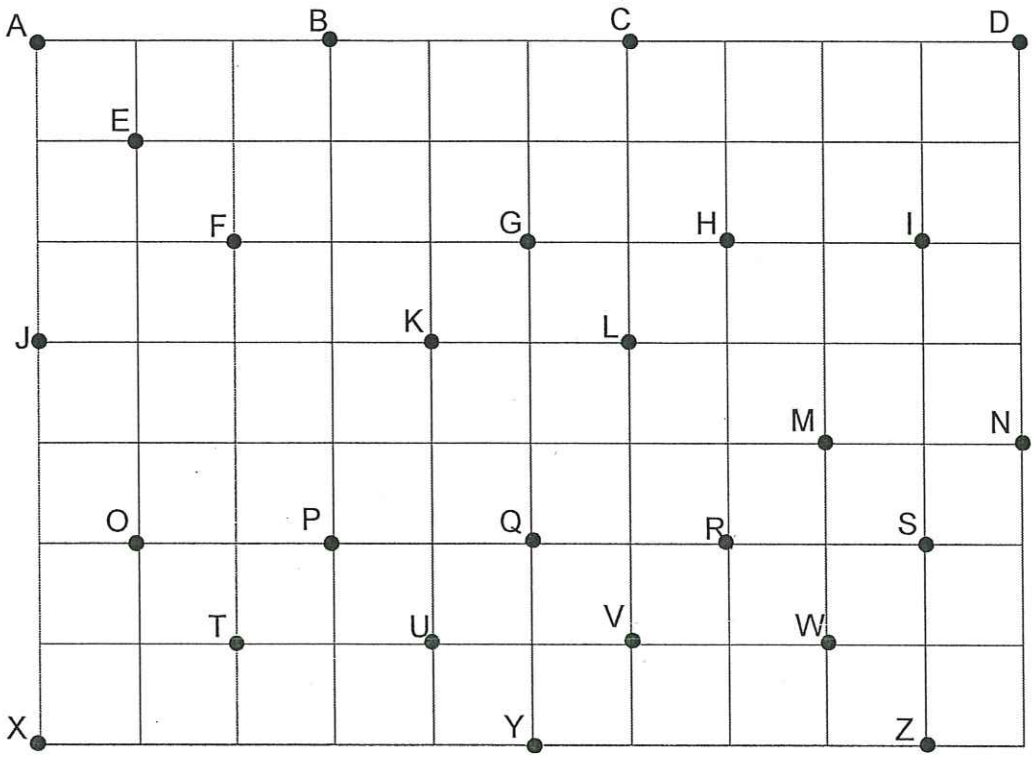
ANNE SURRS

PHY 621 Vector Addition and Subtraction Review Sheet



1. Using the positions indicated on the grid above, identify at least one vector that would answer or represent the following:

a) equal to vector $\overrightarrow{RK}$ — $\vec{MG}$, $\vec{SL}$, $\vec{IC}$

b) equal and opposite to vector $\overrightarrow{QH}$ — $\vec{GP}$, $\vec{IR}$, $\vec{LU}$

c) equal and opposite to vector $\overrightarrow{DG}$ — $\vec{OL}$, $\vec{XQ}$

d) equal to sum of $\overrightarrow{FQ} + \overrightarrow{RN}$ — $\vec{FM}$, $\vec{PZ}$, $\vec{BJ}$

e) equal to sum of $\overrightarrow{XV} + \overrightarrow{GR}$ — $\vec{FN}$, $\vec{OZ}$

f) equal to difference of $\overrightarrow{SK} - \overrightarrow{SY}$ — $\vec{VG}$, $\vec{WH}$

g) equal to difference of $\overrightarrow{PJ} - \overrightarrow{LR}$ — $\vec{VF}$, $\vec{NC}$

h) equal to difference of $\overrightarrow{LS} - \overrightarrow{KP}$ — $\vec{QQ}$, $\vec{PR}$, $\vec{QS}$

i) has the direction [270 °] — $\vec{AJ}$, $\vec{EO}$, $\vec{LV}$

j) has the direction [- 135 °] — $\vec{QU}$, $\vec{MV}$, $\vec{NS}$

k) has the direction [W 45 ° S] — $\vec{QU}$, $\vec{MV}$, $\vec{NS}$

l) has the direction of [S 33.69 ° E] — $\vec{KV}$, $\vec{GR}$, $\vec{EY}$

m) has the direction of [N 18.43 ° E] — $\vec{ZN}$

n) has the direction [348.69°] — $\vec{PW}$

2. The following are a random mix of addition and subtraction word problems.

They are all based on different equations. So, when reading the givens, you need to identify which equation you will need to draw. The answers are to be found using scale diagrams which would include the usual list of givens, scale factor, lengths to be drawn, compass, equation to be drawn, raw measurements, angles (as used in the answer) indicated on drawing, conversions, and, of course, the final vector answer.

a. You first observe a Cedar Waxwing located 45 m [E 30 ° N] of the red oak tree. A few minutes later you observe the same Cedar Waxwing located 80. m [E 50 ° S] of the red oak tree. What was the displacement of the Cedar Waxwing during the observation?

b. Bria and Emily are trying to push a large sofa across the room. Bria exerts a horizontal force of 150. N [S 15 ° W] and Emily pushes with a horizontal force of 120. N [S 30 ° E]. If they push simultaneously, what is the resultant force the ladies exert on the sofa?

c. A plane is flying with a speed of 180. km/h [W 25 ° N] relative to the air. The air (being the wind) is moving at 60. km/h [W 10 ° S] relative to the ground. What is the resultant velocity of the plane as would be observed by you at rest on the ground?

d. Nate and Tony are doing an outdoor expedition. On day one, they are able to hike 22 km [75°] . On day two, the guys hike another 18 km [125°]. On day three, they hike 20 km [195°]. This marks the end of their expedition as they picked up to be transported home. What was their resultant displacement during the hike?

e. You observe a plane flying at 220. km/h [W 20 °S] when it accelerates to a new velocity of 240. km/h [E 80° S]. What was the plane's change in velocity?

f. A boat is observed to be motoring at 50. km/h [S 40 ° W] relative to you at rest on the ground. The current is observed to moving at 20 km/h [S 10 ° W] relative to you at rest on the ground. What is the velocity of the boat relative to the water?

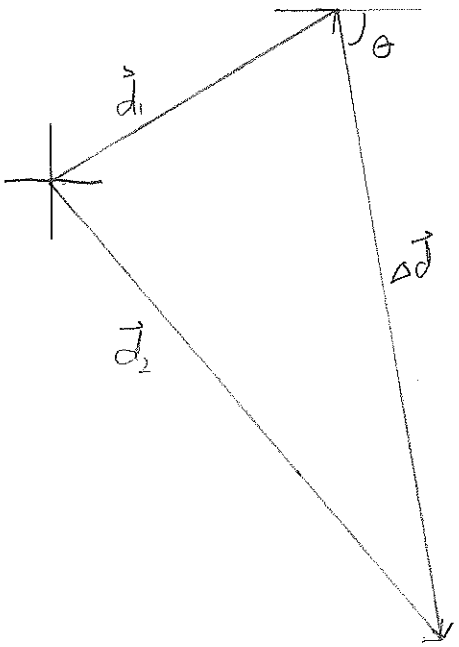
Answers:

a) 85 m [S 9° E]
b) 216 N [E 72° S]
c) 233 km/h [W 17° N]
d) 39 km [W 52 ° N] or [128°]
e) 3.0×10^2 km/h [E 33 ° S]
f) 34 km/h [W 33 ° S]

a) $\vec{d}_1 = 45\ m\ [E\ 30^\circ\ N]$

$\vec{d}_2 = 80.\ m\ [E\ 50^\circ\ S]$

$\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$



Scale: $1.0\ cm = 10\ m$

$45\ m \times \frac{1.0\ cm}{10\ m} = 4.5\ cm$

$80\ m \times \frac{1.0\ cm}{10\ m} = 8.0\ cm$

$\Delta d = 8.5\ cm \times \frac{10\ m}{1.0\ cm} = 85\ m$

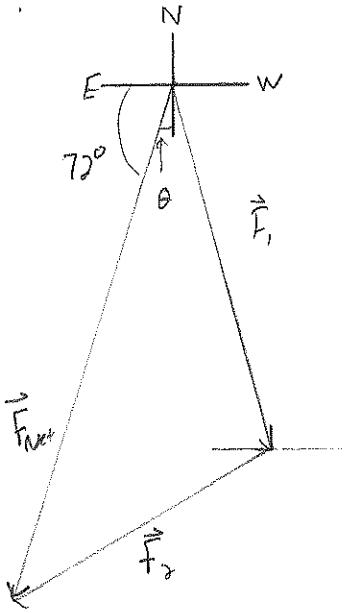
$\theta = -81^\circ$

$\Delta\vec{d} = 85\ m\ [S\ 9^\circ\ E]$

b) $\vec{F}_1 = 150.\ N\ [S\ 15^\circ\ W]$

$\vec{F}_2 = 120.\ N\ [S\ 36^\circ\ E]$

$\vec{F}_{Net} = \vec{F}_1 + \vec{F}_2$



Scale: $1.0\ cm = 30\ N$

$150\ N \times \frac{1.0\ cm}{30\ N} = 5.0\ cm$

$120\ N \times \frac{1.0\ cm}{30\ N} = 4.0\ cm$

$F_{Net} = 7.2\ cm \times \frac{30\ N}{1.0\ cm} = 216\ N$

$\theta = 18^\circ$

$\vec{F}_{Net} = 216\ N\ [E\ 72^\circ\ S]$

c) $\vec{V}_1 = 180\ km/h\ [W\ 25°\ N]$

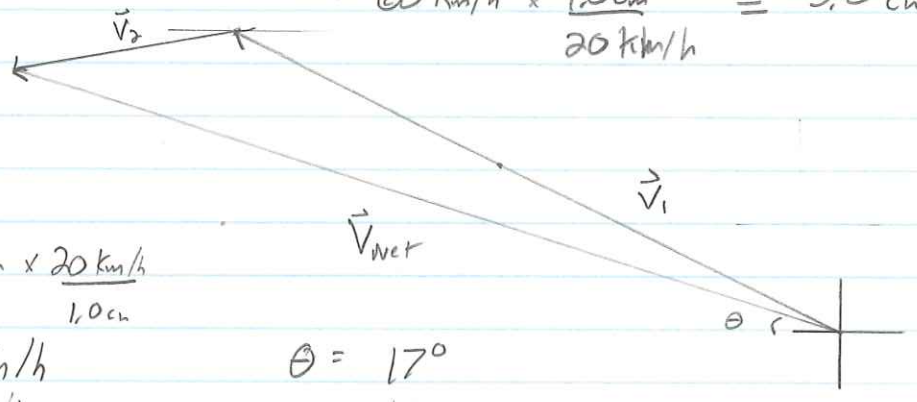
$\vec{V}_2 = 60\ km/h\ [W\ 10°\ S]$

$\vec{V}_{Net} = \vec{V}_1 + \vec{V}_2$

Scale: $1.0\ cm = 20\ km/h$

$180\ km/h \times \frac{1.0\ cm}{20\ km/h} = 9.0\ cm$

$60\ km/h \times \frac{1.0\ cm}{20\ km/h} = 3.0\ cm$



$V_{Net} = 11.6\ cm \times \frac{20\ km/h}{1.0\ cm}$

$= 232\ km/h$

$\theta = 17°$

$\vec{V}_{Net} = 232\ km/h\ [W\ 17°\ N]$

d) $\vec{d}_1 = 22\ km\ [75°]$

$\vec{d}_2 = 18\ km\ [185°]$

$\vec{d}_3 = 20\ km\ [195°]$

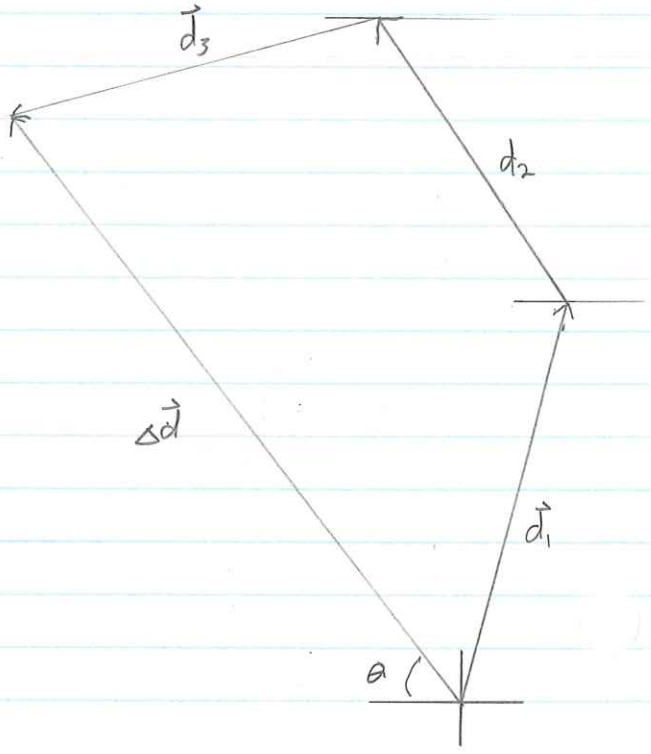
$\Delta\vec{d} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$

Scale: $1.0\ cm = 4.0\ km$

$22\ km \times \frac{1.0\ cm}{4.0\ km} = 5.5\ cm$

$18\ km \times \frac{1.0\ cm}{4.0\ km} = 4.5\ cm$

$20\ km \times \frac{1.0\ cm}{4.0\ km} = 5.0\ cm$



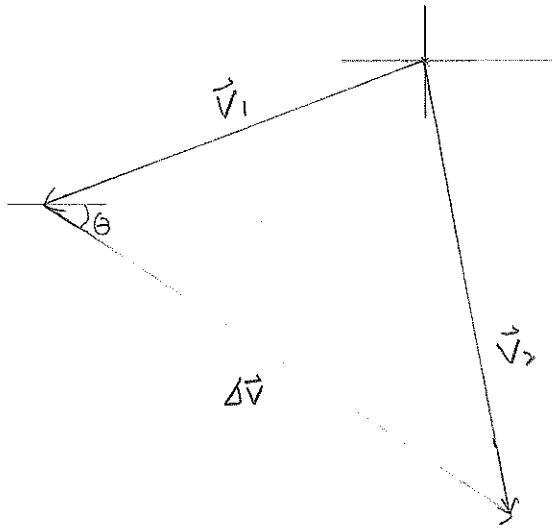
$\Delta d = 9.8\ cm \times \frac{4.0\ km}{1.0\ cm} = 39.2\ km$

$\theta = 52°$

$\Delta\vec{d} = 39.2\ km\ [W\ 52°\ N]$

e) $\vec{V}_1 = 220.\ \text{Km/h}\ [W\ 20^\circ S]$
$\vec{V}_2 = 240.\ \text{Km/h}\ [E\ 80^\circ S]$
$\Delta\vec{V} = \vec{V}_2 - \vec{V}_1$

scale: 1.0 cm = 40 Km/h
$220\ \text{Km/h} \times \frac{1.0\ \text{cm}}{40\ \text{Km/h}} = 5.5\ \text{cm}$
$240\ \text{Km/h} \times \frac{1.0\ \text{cm}}{40\ \text{Km/h}} = 6.0\ \text{cm}$



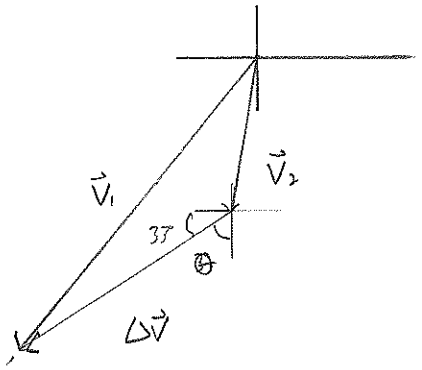
$\Delta v = 7.5\ \text{cm} \times \frac{40\ \text{Km/h}}{1.0\ \text{cm}}$
$= 300\ \text{Km/h}$

$\theta = 33^\circ$

$\Delta\vec{V} = 3.0 \times 10^2\ \text{Km/h}\ [E\ 33^\circ S]$

f) $\vec{V}_1 = 50.\ \text{Km/h}\ [S\ 40^\circ W]$
$\vec{V}_2 = 20.\ \text{Km/h}\ [S\ 10^\circ W]$
$\Delta\vec{V} = \vec{V}_1 - \vec{V}_2$

scale: 1.0 cm = 10 Km/h
$50\ \text{Km/h} \times \frac{1.0\ \text{cm}}{10\ \text{Km/h}} = 5.0\ \text{cm}$
$20\ \text{Km/h} \times \frac{1.0\ \text{cm}}{10\ \text{Km/h}} = 2.0\ \text{cm}$



$\theta = 57^\circ$

$\Delta v = 3.3\ \text{cm} \times \frac{10\ \text{Km/h}}{1.0\ \text{cm}} = 33\ \text{Km/h}$

$\Delta\vec{V} = 33\ \text{Km/h}\ [W\ 33^\circ S]$