1. (10 points) A glider (an airplane without an engine) is flying at a velocity of 50 km/hour 36.9° north of east. The wind is blowing with a velocity of 28.3 km/hour 45° south of west.

   a. Consider the positive x-direction to be east and the positive y-direction to be north. Find the x- and y-components of each vector.

   **Glider:**
   \[ x\text{-comp}: \quad 50.0 \text{ km/hr} \cos(36.9°) = 40.0 \text{ km/hr} \]
   \[ y\text{-comp}: \quad 50.0 \text{ km/hr} \sin(36.9°) = 30.0 \text{ km/hr} \]

   **Wind:**
   \[ x\text{-comp}: \quad 28.3 \text{ km/hr} \cos(45°) = 20.0 \text{ km/hr} \text{ (negative since in 3rd quadrant)} \]
   \[ y\text{-comp}: \quad 28.3 \text{ km/hr} \sin(45°) = -20.0 \text{ km/hr} \text{ (negative since in 3rd quadrant)} \]

   b. On the grid below, sketch in these two vectors. I recommend using the dot as the origin of your coordinate system. (You don’t need a straight edge or protractor – use your answers to part a to place the vectors.)

   ![Grid with vectors](image)

   c. Sketch in the resultant of adding the two vectors in the drawing above (tip-to-tail method).

   d. What are the magnitude and direction of the resultant vector? Calculate these—don’t use your sketch.

   \[ x: \quad 40.0 \text{ km/hr} + (-20.0 \text{ km/hr}) = 20.0 \text{ km/hr} \]
   \[ y: \quad 30.0 \text{ km/hr} + (-20.0 \text{ km/hr}) = 10.0 \text{ km/hr} \]

   \[ \text{MAGNITUDE} = \sqrt{(20.0 \text{ km/hr})^2 + (10.0 \text{ km/hr})^2} \]

   \[ \theta: \quad \tan^{-1} \theta = \frac{10.0 \text{ km/hr}}{20.0 \text{ km/hr}} = 26.6° \text{ above x-axis} \]
2. (10 points) A ball is thrown into the air with an initial velocity of 15.0 m/s at an angle of 25.0° above the horizontal. Ignore air resistance in the following.

a. What are the horizontal and vertical components of velocity of the ball initially?

\[
\begin{align*}
\vec{v}_0 &= 15.0\text{m/s} \times \cos 25.0^\circ \text{ (horizontal)} \\
\vec{v}_0 &= 15.0\text{m/s} \times \cos 25.0^\circ \\
\vec{v}_0 &= \left(6.34\text{m/s}\right) \text{ (horizontal)} \\
\end{align*}
\]

b. How high vertically will the ball go into the air?

\[
\begin{align*}
v &= v_0 + gt \\
\frac{v^2}{2} &= v_0^2 + 2g(y - y_0) \\
g^2 &= \left(6.34\text{m/s}\right)^2 + 2(-9.8\text{m/s}^2)(y - y_0) \\
y - y_0 &= \frac{-6.34^2 + 0}{-2(9.8)} \\
y - y_0 &= 2.05\text{m} \\
\end{align*}
\]

c. How long (in s) will it take for the ball to come back down to the same height at which it left the thrower's hand?

\[
\begin{align*}
\frac{v - v_0}{g} &= \frac{-6.34^2 + 0}{-2(9.8)} \\
t &= 1.29\text{s} \\
\end{align*}
\]

d. Suppose the same throw of the ball is made on a planet on which the acceleration due to gravity is given by the expression g(t) = 1.5 t^2. Remembering that a = dv/dt and, as a result, dv = adt, how fast would the ball be traveling after 2.0 s?

\[
\begin{align*}
dv &= v \frac{dv}{dt} \\
\int _{v_0} ^{v} dv &= \int _{t_0} ^{t} g dt \\
\int _{v_0} ^{v} dv &= \int _{t_0} ^{t} 1.5t^2 \ dt \\
v &= v_0 + gt \\
v &= v_0 + v_0 t + 1/2 g t^2 \\
v^2 &= v_0^2 + 2g(y - y_0) \\
v &= v + v_0 \\
v &= \frac{v + v_0}{2} \\
v &= 6.34\text{m/s} \\
v &= 6.3\text{m/s} \\
\end{align*}
\]