SOLUTION

1. (2 pts) Express the vector \( u \) in terms of \( a, b, c \).

\[
\vec{u} = a - b - c
\]

or other correct variations OK, but should solve for \( u \) as

\[
\begin{align*}
\vec{u} - a + b + c &= 0 \\
\vec{u} + c + b &= a
\end{align*}
\]

2. (2 pts) Sarah throws a tennis ball straight down from the 1st floor balcony in Estabrook
with a speed of 39 ft/s. Jason throws a tennis ball straight up from the 1st floor balcony with
the same speed. What can we say about the speed of the tennis balls when they hit the floor.
Ignore air resistance.

A. Sarah’s tennis ball hits the floor with a greater speed
B. Both tennis balls hit the floor with the same speed
C. Jason’s tennis ball hits the floor with a greater speed

3. (6 pts) Determine the area of a 12 m radius circle in Est201’s.

1 Est201 = 14 square Andrews
1 Andrews = 5 feet 11 inches
1 ft = 0.3048 m

\[
\text{Area} = \pi \left( 12 \text{ m} \right)^2 \left( \frac{5 \text{ ft}}{0.3048 \text{ m}} \right)^2 \left( \frac{1 \text{ Andrews}}{5 \text{ ft}} \right)^2 = \frac{\text{Est201}}{14 \text{ Andrews}^2} = 9.94 \text{ Est201}
\]

4. (6 pts) Given two vectors: \( \vec{A} = (-5 \hat{i} - 6 \hat{j}) \) and \( \vec{B} = (4 \hat{j}) \). Determine the angle of \( \vec{A} + \vec{B} \)
(counterclockwise from x-axis).

\[
\vec{A} + \vec{B} = -5 \hat{i} - 6 \hat{j} + 4 \hat{j} = -5 \hat{i} - 2 \hat{j}
\]

\[
\theta = \tan^{-1} \left( \frac{-2}{-5} \right) = 21.8^\circ
\]

\[
\alpha = \theta + 180^\circ = 202^\circ
\]
5. (14 pts) A Mini Cooper starts at position 340 ft and follows the velocity-time graph shown. Determine the position and acceleration at the end of 7 seconds.

\[ s = 522 \text{ ft} \]
\[ a = -4 \text{ ft/s}^2 \]

\[ \Delta s = \text{area} = \frac{1}{2} (v_1 + v_2)(t) \]
\[ = 182 \text{ ft} \]
\[ s = 5, + \Delta s = 340 + 182 \]
\[ = 522 \text{ ft} \]

\[ a = \frac{\Delta v}{\Delta t} = \frac{12-40}{7} \]
\[ = -4 \text{ ft/s}^2 \]

1 Math Error (ME)
-4 only solved for area of triangle (not trapezoid)

-4 only solved for area of trapezoid

-2 Formula/equation error
-4 didn't use correct \( s_0, v_0, \) etc
-4 didn't solve for \( a \) for \( a = \frac{\Delta v}{\Delta t} \)

6. (14 pts) Taylor walks her horse 600 ft in 54 seconds, another 400 ft at 9 ft/s, and then at 7 ft/s for 38 seconds. Determine her average speed for the trip.

\[ 9.28 \text{ ft/sec} \]

\[ v = \frac{s}{t} \]
\[ t = \frac{s}{v} \]

\[ \text{avg speed} = \frac{\text{tot dist.}}{\text{tot time}} = \frac{600 + 400 + 7(38)}{54 + \frac{400}{9} + 38} \]
\[ = \frac{600 + 400 + 266}{54 + 44.44 + 38} \]
\[ = \frac{1266}{136.44 \text{ sec}} \]
\[ = 9.28 \text{ ft/sec} \]

-5 \( \frac{v_1 + v_2 + v_3}{3} \)
-10 \( \frac{600 + 400}{54 + 38} \)
7. (14 pts) Brandi is riding a bike that is going at 23 ft/s. She puts on her brakes which causes the bike to slow down at a rate of 1.6 ft/s². When the speed has been reduced to 14 ft/s, she brakes harder, causing the bike to slow down with a constant acceleration and come to a stop in 4 seconds. Determine the distance the bike traveled.

\[ v_1 = 23 \]
\[ v_2 = 14 \]
\[ a = -1.6 \]

\[ \Delta s = \frac{v_2^2 - v_1^2}{2a} = \frac{14^2 - 23^2}{2(-1.6)} \]
\[ = 104 \text{ ft} \]

\[ v_1 = 14 \]
\[ v_2 = 0 \]
\[ \Delta t = 4 \]

\[ \Delta s = \frac{v_1 + v_2}{2} \Delta t = \frac{14 + 0}{2} \]
\[ = 28 \text{ ft} \]

\[ \Delta s_{tot} = 104 + 28 = 132 \text{ ft} \]

8. (14 pts)
Rachel throws a football with an initial velocity of \((16i + 23j)ft/s\). The initial position is the origin, and the acceleration is \((-32.2j)ft/s^2\). Determine the x position of the football when it is at the maximum y position.

\[ v_i = 16i + 23j \text{ ft/s} \]
\[ s_i = 0i + 0j \text{ ft} \]
\[ a = -32.2j \text{ ft/s}^2 \]

Max y when \( v_y = 0 \)
\[ v_y = v_{yi} + ay \]
\[ 0 = 23 - 32.2t \]
\[ t = 0.714 \text{ sec} \]

\[ x = x_i + v_{xi}t + \frac{1}{2}a_xt^2 \]
\[ = 0 + 16(0.714)^2 + 0 \]
\[ = 11.4 \text{ ft} \]
9. (14 pts) Daniel walks 200 yards west and then 500 yards north. Tyler starts from the same place as Daniel started and walks 360 yards at a heading of 60° N of E. How far does Daniel have to walk to meet Tyler?

\[ 424 \text{ yd} \]

\[ T = \sqrt{D_x^2 + D_y^2} \]

\[ D_x = 360 \cos 60° \]

\[ D_y = -188 \text{ yd} \]

\[ D = \frac{380}{\cos (26.35°)} \]

\[ D = 424 \text{ yd} \]
10. (14 pts) This system of four forces is in equilibrium. What is the magnitude of A?

\[ 8.65 \text{ lb} \]

Equilibrium \[ \Rightarrow \vec{A} + \vec{B} + \vec{C} + \vec{D} = 0 \]

<table>
<thead>
<tr>
<th>MAG</th>
<th>ANG</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>0</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>20°</td>
<td>Bcos30° - Bsin30°</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>20°</td>
<td>-15cos20° - 15sin20°</td>
<td></td>
</tr>
</tbody>
</table>

\[ \begin{align*}
X: & \quad 0 + B\cos30° + 8 - 15\cos20° = 0 \quad \Rightarrow \quad B = 7.038 \text{ lb} \\
Y: & \quad A - B\sin30° + 0 - 15\sin20° = 0 \quad \checkmark \quad +2 \text{ equ.}
\end{align*} \]

\[ A - 7.038(\sin30°) - 15\sin20° = 0 \]

\[ A = 8.65 \text{ lb} \]

-2 per missed section

\[ 10 \]

-1 wrong unknown