1) $\underset{2\ 1}{\begin{bmatrix}1\\2\end{bmatrix}} \cdot \underset{2\ 1}{\begin{bmatrix}1\\2\end{bmatrix}} = \underset{1\ 2}{\begin{bmatrix}1&2\end{bmatrix}} \begin{bmatrix}1\\2\end{bmatrix} = 1\cdot1 + 2\cdot2 = 5$

2) $\underset{2\ 1}{\begin{bmatrix}1\\2\end{bmatrix}} \cdot \underset{3\ 1}{\begin{bmatrix}2\\4\\6\end{bmatrix}}$ = Not same size, can't do

3) $\underset{3\ 1}{\begin{bmatrix}2\\4\\6\end{bmatrix}} \cdot \underset{2\ 1}{\begin{bmatrix}1\\2\end{bmatrix}}$ = Not same size, can't do

4) $\underset{3\ 1}{\begin{bmatrix}2\\4\\6\end{bmatrix}} \cdot \underset{3\ 1}{\begin{bmatrix}2\\4\\6\end{bmatrix}} = \underset{1\ 3}{\begin{bmatrix}2&4&6\end{bmatrix}} \begin{bmatrix}2\\4\\6\end{bmatrix} = 2\cdot2 + 4\cdot4 + 6\cdot6 = \boxed{56}$

5) $\underset{1\ 2}{\begin{bmatrix}1&2\end{bmatrix}} \underset{2\ 1}{\begin{bmatrix}1\\2\end{bmatrix}} = \begin{bmatrix}1\cdot1 + 2\cdot2\end{bmatrix} = \boxed{[5]}$

6) $\underset{2\ 1}{\begin{bmatrix}1\\2\end{bmatrix}} \underset{1\ 2}{\begin{bmatrix}1&2\end{bmatrix}} = \begin{bmatrix}1\cdot1 & 1\cdot2\\ 2\cdot1 & 2\cdot2\end{bmatrix} = \begin{bmatrix}1&2\\2&4\end{bmatrix}$

7) $\underset{1\ 2}{\begin{bmatrix}10&20\end{bmatrix}} \cdot \underset{1\ 2}{\begin{bmatrix}10&20\end{bmatrix}} = \begin{bmatrix}10&20\end{bmatrix}\begin{bmatrix}10\\20\end{bmatrix} = 10\cdot10 + 20\cdot20 = 100 + 400 = \boxed{500}$

8) $\underset{1\ 3}{\begin{bmatrix}1&0&1\end{bmatrix}} \cdot \underset{1\ 3}{\begin{bmatrix}1&0&1\end{bmatrix}} = \begin{bmatrix}1&0&1\end{bmatrix}\begin{bmatrix}1\\0\\1\end{bmatrix} = 1\cdot1 + 0\cdot0 + 1\cdot1 = \boxed{2}$

9) $\underset{1\ 2}{\begin{bmatrix}10&20\end{bmatrix}} \cdot \underset{1\ 3}{\begin{bmatrix}1&0&1\end{bmatrix}}$ = Not same size, can't do

10) $\underset{1\ 3}{\begin{bmatrix}1&0&1\end{bmatrix}} \cdot \underset{1\ 2}{\begin{bmatrix}10&20\end{bmatrix}}$ = Not same size, can't do

11) $\begin{bmatrix}10\\20\end{bmatrix}\begin{bmatrix}10&20\end{bmatrix} = \begin{bmatrix}10\cdot10 + 20\cdot20\end{bmatrix} = \begin{bmatrix}100 + 400\end{bmatrix} = \begin{bmatrix}500\end{bmatrix}$

12) $\begin{bmatrix}10&20\end{bmatrix}\begin{bmatrix}10\\20\end{bmatrix} = \begin{bmatrix}10\cdot10 & 10\cdot20\\ 20\cdot10 & 20\cdot20\end{bmatrix}$

13) $\underset{2\ 2}{\begin{bmatrix}1&2\\0&1\end{bmatrix}}\underset{2\ 2}{\begin{bmatrix}1&2\\0&1\end{bmatrix}} = \begin{bmatrix}1\cdot1+2\cdot0 & 1\cdot2+2\cdot1\\ 0\cdot1+1\cdot0 & 0\cdot2+1\cdot1\end{bmatrix} = \begin{bmatrix}1&4\\0&1\end{bmatrix}$

14) $\underset{2\ 2}{\begin{bmatrix}1&2\\0&1\end{bmatrix}}\underset{3\ 3}{\begin{bmatrix}1&-1&2\\2&0&3\\3&1&2\end{bmatrix}}$ = $\text{Columns}_A \neq \text{Rows}_B$, Not possible

15) $\underset{2}{\begin{bmatrix}1&2\\0&1\end{bmatrix}}\underset{2}{\begin{bmatrix}1&2&2\\2&-1&1\end{bmatrix}}_{3} = \begin{bmatrix}1\cdot1+2\cdot2 & 1\cdot2+2\cdot(-1) & 1\cdot2+2\cdot1\\ 0\cdot1+1\cdot2 & 0\cdot2+1\cdot(-1) & 0\cdot2+1\cdot1\end{bmatrix} = \begin{bmatrix}5&0&4\\2&-1&1\end{bmatrix}$

16) $\underset{2}{\begin{bmatrix}1&2\\0&1\end{bmatrix}}\underset{3}{\begin{bmatrix}1&2\\2&1\\-1&1\end{bmatrix}}_{3}$ = Columns$_A$ ≠ Rows$_B$, Not possible

17) $\underset{2}{\begin{bmatrix}1&2\\0&1\end{bmatrix}}\underset{2}{\begin{bmatrix}1/2&-\frac{\sqrt3}{2}\\ \frac{\sqrt3}{2}&1/2\end{bmatrix}}_{2} = \begin{bmatrix}1\cdot1/2+2\cdot\frac{\sqrt3}{2} & 1\cdot(-\frac{\sqrt3}{2})+2\cdot1/2\\ 0\cdot1/2+1\cdot\frac{\sqrt3}{2} & 0\cdot(-\frac{\sqrt3}{2})+1\cdot1/2\end{bmatrix} =$

18) $\underset{3}{\begin{bmatrix}1&-1&2\\2&0&3\\3&1&2\end{bmatrix}}\underset{3}{\begin{bmatrix}1&2&2\\2&-1&1\end{bmatrix}}_{3} =$

3 2

19) $\underset{3}{\begin{bmatrix}1&-1&2\\2&0&3\\3&1&2\end{bmatrix}}\underset{2}{\begin{bmatrix}1&2\\2&-1\\2&1\end{bmatrix}} = \begin{bmatrix}1\cdot1+(-1)\cdot2+2\cdot2 & 1\cdot2+(-1)\cdot(-1)+2\cdot1\\ 2\cdot1+0\cdot2+3\cdot2 & 2\cdot2+0\cdot(-1)+3\cdot1\\ 3\cdot1+1\cdot2+2\cdot2 & 3\cdot2+1\cdot(-1)+2\cdot1\end{bmatrix} = \begin{bmatrix}3&5\\8&7\\9&7\end{bmatrix}$

3 3

20) $\underset{3}{\begin{bmatrix}1&-1&2\\2&0&3\\3&1&2\end{bmatrix}}\underset{3}{\begin{bmatrix}1&2\\2&1\\-1&1\end{bmatrix}}_{2} = \begin{bmatrix}1\cdot1+(-1)\cdot2+2\cdot(-1) & 1\cdot2+(-1)\cdot1+2\cdot1\\ 2\cdot1+0\cdot2+3\cdot(-1) & 2\cdot2+0\cdot1+3\cdot1\\ 3\cdot1+1\cdot2+2\cdot(-1) & 3\cdot2+1\cdot1+2\cdot1\end{bmatrix} = \begin{bmatrix}-3&3\\-1&5\\3&8\end{bmatrix}$

21) $\underset{2}{\begin{bmatrix}1&2&2\\2&-1&1\end{bmatrix}}\underset{3}{\begin{bmatrix}1&2\\2&1\\-1&1\end{bmatrix}}_{2} = \begin{bmatrix}1\cdot1+2\cdot2+2\cdot(-1) & 1\cdot2+2\cdot1+2\cdot1\\ 2\cdot1+(-1)\cdot2+1\cdot(-1) & 2\cdot2+(-1)\cdot1+1\cdot1\end{bmatrix} = \begin{bmatrix}3&6\\-1&4\end{bmatrix}$

22) $\underset{2}{\overset{E}{\begin{bmatrix}1/2&-\frac{\sqrt3}{2}\\ \frac{\sqrt3}{2}&1/2\end{bmatrix}}}\underset{2}{\overset{E}{\begin{bmatrix}1/2&-\frac{\sqrt3}{2}\\ \frac{\sqrt3}{2}&1/2\end{bmatrix}}} = \begin{bmatrix}1/4-\frac{3}{4} & -\frac{\sqrt3}{4}-\frac{\sqrt3}{4}\\ 1/2\cdot1/2+(-\frac{\sqrt3}{2})\cdot\frac{\sqrt3}{2} & 1/2\cdot(-\frac{\sqrt3}{2})+(-\frac{\sqrt3}{2})\cdot1/2\\ \sqrt3/2\cdot1/2+1/2\cdot\frac{\sqrt3}{2} & \sqrt3/2\cdot(-\frac{\sqrt3}{2})+1/2\cdot1/2\\ \frac{\sqrt3}{4}+\frac{\sqrt3}{4} & -\frac{\sqrt3}{4}+\frac{1}{4}\end{bmatrix} = \begin{bmatrix}-1/2&-\frac{\sqrt3}{2}\\ \frac{\sqrt3}{2}&-\frac{\sqrt3+1}{4}\end{bmatrix}$

23) $\underset{2}{\overset{E}{\begin{bmatrix}1/2&-\frac{\sqrt3}{2}\\ \frac{\sqrt3}{2}&1/2\end{bmatrix}}}\underset{2}{\overset{E^T}{\begin{bmatrix}-\sqrt3/2&1/2\\1/2&\sqrt3/2\end{bmatrix}}} = \begin{bmatrix}-\frac{\sqrt3}{4}-\frac{\sqrt3}{4} & \frac{1}{4}-\frac{\sqrt3}{4}\\ 1/2\cdot(-\sqrt3/2)+(-\sqrt3/2)\cdot1/2 & 1/2\cdot1/2+(-\sqrt3/2)\cdot\frac{\sqrt3}{2}\\ \sqrt3/2\cdot(-\sqrt3/2)+1/2\cdot1/2 & \sqrt3/2\cdot1/2+1/2\cdot\sqrt3/2\\ -\frac{\sqrt3}{4}+\frac{1}{4} & \frac{\sqrt3}{4}+\frac{\sqrt3}{4}\end{bmatrix} = \begin{bmatrix}-\frac{\sqrt3}{2}&\frac{1-\sqrt3}{4}\\ -\frac{\sqrt3+1}{4}&\frac{\sqrt3}{2}\end{bmatrix}$

24) $\underset{2}{\overset{E^T}{\begin{bmatrix}-\sqrt3/2&1/2\\1/2&\sqrt3/2\end{bmatrix}}}\underset{2}{\overset{E}{\begin{bmatrix}1/2&-\frac{\sqrt3}{2}\\ \frac{\sqrt3}{2}&1/2\end{bmatrix}}} = \begin{bmatrix}-\frac{\sqrt3}{4}+\frac{\sqrt3}{4} & \frac{\sqrt3}{4}+\frac{1}{4}\\ -\sqrt3/2\cdot1/2+1/2\cdot\sqrt3/2 & -\sqrt3/2\cdot-\sqrt3/2+1/2\cdot1/2\\ 1/2\cdot1/2+\sqrt3/2\cdot\sqrt3/2 & 1/2\cdot-\sqrt3/2+\sqrt3/2\cdot1/2\\ 1/4+\frac{\sqrt3}{4} & -\frac{\sqrt3}{4}+\frac{\sqrt3}{4}\end{bmatrix} = \begin{bmatrix}0&\frac{\sqrt3+1}{4}\\ \frac{\sqrt3+1}{4}&0\end{bmatrix}$

25) $y = \begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix}$ $y \times y$ $\begin{bmatrix} 0 & -a_3 & a_2 \\ a_3 & 0 & -a_1 \\ -a_2 & a_1 & 0 \end{bmatrix}$

$$\underset{3}{\begin{bmatrix} 0 & -6 & 4 \\ 6 & 0 & -2 \\ -4 & 2 & 0 \end{bmatrix}} \underset{3}{\begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix}} = \underset{3}{\begin{bmatrix} 0\cdot 2 - 6\cdot 4 + 6\cdot 4 \\ 6\cdot 2 + 0\cdot 4 - 2\cdot 6 \\ -4\cdot 2 + 2\cdot 4 + 0\cdot 6 \end{bmatrix}} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

26) $x \times y$ = Can't do, not same size

27) $y \times v^T = \begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix} \times \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 & -6 & 4 \\ 6 & 0 & -2 \\ -4 & 2 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0\cdot 1 + (-6)\cdot 0 + 4\cdot 1 \\ 6\cdot 1 + 0\cdot 0 - 2\cdot 0 \\ -4\cdot 1 + 2\cdot 0 + 0\cdot 1 \end{bmatrix} = \begin{bmatrix} 4 \\ 6 \\ -4 \end{bmatrix}$

28) $v^T \times y = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \times \begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & -1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix} = \begin{bmatrix} 0\cdot 2 + (-1)\cdot 4 + 0\cdot 6 \\ 1\cdot 2 + 0\cdot 4 + (-1)\cdot 6 \\ 0\cdot 2 + 1\cdot 4 + 0\cdot 6 \end{bmatrix} = \begin{bmatrix} -4 \\ -4 \\ 4 \end{bmatrix}$

29) $E \times$

$$\underset{2}{\begin{bmatrix} 1/2 & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & 1/2 \end{bmatrix}} \underset{2}{\begin{bmatrix} 1 \\ 2 \end{bmatrix}} = \underset{\sqrt{3}/2 + 1}{\begin{bmatrix} 1/2 \cdot 1 + (-\sqrt{3}/2)\cdot 2 \\ \sqrt{3}/2 \cdot 1 + 1/2 \cdot 2 \end{bmatrix}} = \begin{bmatrix} 1-\sqrt{3} \\ \sqrt{3}/2 + 1 \end{bmatrix}$$

30) $E\,v$

$$\underset{2}{\begin{bmatrix} 1/2 & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & 1/2 \end{bmatrix}} \underset{2}{\begin{bmatrix} 10 & 20 \end{bmatrix}} = \text{Can't do, not same size}$$

Part 2 $r = \sqrt{x^2 + y^2}$ $\theta = \tan^{-1}\left(\frac{y}{x}\right)$

1. q1 (4, 2)

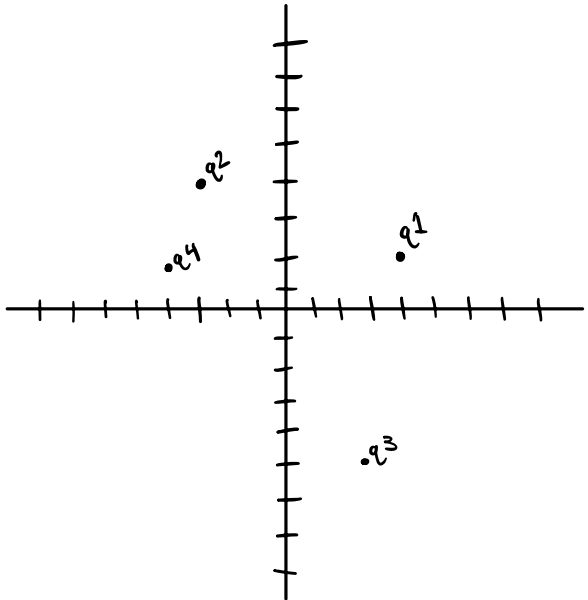
$r = \sqrt{4^2 + 2^2} = \sqrt{16+4} = \sqrt{20} = 4.47$

$\theta = \tan^{-1}\left(\frac{2}{4}\right) = \tan^{-1}\left(\frac{1}{2}\right) = 0.46 = 26.56°$

2. q2 (-3, 4)

$r = \sqrt{-3^2 + 4^2} = \sqrt{9+16} = \sqrt{25} = 5$

$\theta = \tan^{-1}\left(\frac{4}{-3}\right) = -53.13° = 306.86°$



3. $q3(3, -5)$

$r = \sqrt{3^2 + -5^2} = \sqrt{9+25} = \sqrt{34} = 5.83$

$\theta = \tan^{-1}\left(\frac{-5}{3}\right) = -59.03^\circ = 300.96^\circ$

4. $q4(-4, 2)$

$r = \sqrt{-4^2 + 2^2} = \sqrt{16+4} = 4.47$

$\theta = \tan^{-1}\left(\frac{2}{-4}\right) = -26.56^\circ = 333.43^\circ$

Part 3

5. $q5(r=4, \theta = 30^\circ)$ (3.46, 2) Degrees = radians $\times \frac{180}{\pi}$

$x = r \cdot \cos\theta = (4)(\cos(30)) = 3.46$

$y = r \cdot \sin\theta = (4)(\sin(30)) = 2$

6. $q6(r=3, \theta = 0.707$ radians) (2.28, 1.94) $\text{Deg} = .707 \times \frac{180}{\pi} = 40.5$

$x = r\cdot\cos\theta = 3\cos(.707) \Rightarrow 3\cos(40.5^\circ) = 2.28$

$y = r\cdot\sin\theta = 3\sin(.707) \Rightarrow 3\sin(40.5^\circ) = 1.94$

7. $q7(r=4, \theta = 2.41$ rads) (-2.97, 2.67) $\text{Deg} = 2.41 \times \frac{180}{\pi} = 138.08$

$x = r\cos\theta = 4\cos(2.41) \Rightarrow 4\cos(138.08^\circ) = -2.97$

$y = r\sin\theta = 4\sin(2.41) \Rightarrow 4\sin(138.08) = 2.67$

8. $q8(r=-4, \theta = 235^\circ)$ (2.67, 3.27)

$x = r\cos\theta = -4\cos(235) = 2.67$

$y = r\sin\theta = -4\sin(235) = 3.27$