

Part 1

1.

- There exists a value "p" that is less than 3 and "q" that is less than 3 such that "p" multiplied by "q" is greater than 9. **True.** Ex: (-1×-10)
- "a" added to "b" is an integer if and only if "a" is an integer and "b" is an integer. **False.** Ex: $(1.25 + 1.75 = 3)$
- "m" is rational and "n" is rational implies "m" divided by "n" is rational. **False.** (n=0)
- "x" squared is greater than the absolute value of "x" for all "x" greater than or equal to 1. **False.** Ex: $1^2 = |1|$

2.

- $\begin{pmatrix} 2 & -1 \\ 4 & 6 \end{pmatrix} \begin{pmatrix} 7 \\ 3 \end{pmatrix} - \begin{pmatrix} 4 \\ 1 \end{pmatrix} = \begin{pmatrix} 11 \\ 46 \end{pmatrix} - \begin{pmatrix} 4 \\ 1 \end{pmatrix} = \begin{pmatrix} 7 \\ 45 \end{pmatrix}$
- $\begin{pmatrix} -1 & -a \\ 0 & 2 \end{pmatrix} \begin{pmatrix} 3 & 1 \\ b & -1 \end{pmatrix}^T = \begin{pmatrix} -1 & -a \\ 0 & 2 \end{pmatrix} \begin{pmatrix} 3 & b & 0 \\ 1 & -1 & 2 \end{pmatrix} = \begin{pmatrix} -3-a & -b+a & -2a \\ 2 & -2 & 4 \end{pmatrix}$

3. $\mathbf{y} = \begin{pmatrix} 3 \\ \theta \\ -2 \end{pmatrix}$

- $\mathbf{y} \cdot \mathbf{y} = \begin{pmatrix} 3 \\ \theta \\ -2 \end{pmatrix} \cdot \begin{pmatrix} 3 \\ \theta \\ -2 \end{pmatrix} = 9 + \theta^2 + 4 = \mathbf{13 + \theta^2}$
 - $\mathbf{y}^T \mathbf{y} = \mathbf{y} \cdot \mathbf{y} = \mathbf{13 + \theta^2}$
4. $\mathbf{x}^T \mathbf{Q} \mathbf{x} = (x_1 \ x_2) \begin{pmatrix} 1 & -2 \\ -2 & 3 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = (x_1 - 2x_2 \ -2x_1 + 3x_2) \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = (x_1(x_1 - 2x_2) + x_2(-2x_1 + 3x_2)) = x_1^2 - 2x_1x_2 - 2x_1x_2 + 3x_2^2 = \mathbf{x_1^2 - 4x_1x_2 + 3x_2^2}$
5. $f(k_1x_1 + k_2x_2) = k_1f(x_1) + k_2f(x_2)$
- $f(\beta) = \beta x^2 \rightarrow (k_1x_1 + k_2x_2)x^2 = k_1x_1x^2 + k_2x_2x^2 \rightarrow \text{True: Linear}$
 - $f(x) = \frac{dx}{dt} \rightarrow \frac{d}{dt}(k_1x_1 + k_2x_2) = k_1 \frac{d}{dt}(x_1) + k_2 \frac{d}{dt}(x_2) = k_1f(x_1) + k_2f(x_2) \rightarrow \text{True: Linear}$
 - $f(x) = \int x \, dx = \int (k_1x_1 + k_2x_2) \, dx = k_1 \int x_1 \, dx + k_2 \int x_2 \, dx \rightarrow \text{True: Linear}$
6. $\mathbf{a} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}, \mathbf{b} = \begin{pmatrix} 0 \\ 4 \end{pmatrix}$
- $\|\mathbf{a}\| = \sqrt{(-2)^2 + 1^2} = \mathbf{\sqrt{5}}$
 - $\|\mathbf{b}\| = \sqrt{(0)^2 + 4^2} = \mathbf{4}$
 - $\|\mathbf{a} + \mathbf{b}\| = \left\| \begin{pmatrix} -2 \\ 5 \end{pmatrix} \right\| = \sqrt{(-2)^2 + 5^2} = \mathbf{\sqrt{29}}$
 - $\|3\mathbf{a}\| = \left\| \begin{pmatrix} -6 \\ 3 \end{pmatrix} \right\| = \sqrt{(-6)^2 + 3^2} = \mathbf{\sqrt{45} = 3\sqrt{5}}$
7. $\mathbf{x} \cdot \mathbf{y} = \|\mathbf{x}\| \|\mathbf{y}\| \cos \theta$
- $\rightarrow 2 = \sqrt{14}\sqrt{3} \cos \theta \rightarrow \theta = \cos^{-1}\left(\frac{2}{\sqrt{14}\sqrt{3}}\right) = \mathbf{72.02^\circ}$
 - $\rightarrow \text{dot product} = 0 \rightarrow \mathbf{90^\circ}$
8. $\mathbf{a} = \begin{pmatrix} 1 \\ k \\ 2 \end{pmatrix}, \mathbf{b} = \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$
- $\mathbf{a}^T \mathbf{b} = (1 \ k \ 2) \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix} = \mathbf{(k + 4)}$

$$\text{b. } \mathbf{ab}^T = \begin{pmatrix} 1 \\ k \\ 2 \end{pmatrix} \begin{pmatrix} 0 & 1 & 2 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 2 \\ 0 & k & 2k \\ 0 & 2 & 4 \end{pmatrix}$$

$$\text{c. } \mathbf{ba}^T = \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix} \begin{pmatrix} 1 & k & 2 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 \\ 1 & k & 2 \\ 2 & 2k & 4 \end{pmatrix} \text{ or } \mathbf{ba}^T = (\mathbf{ab}^T)^T = \begin{pmatrix} 0 & 0 & 0 \\ 1 & k & 2 \\ 2 & 2k & 4 \end{pmatrix}$$

9.

```

1 - d = [0;0;1];
2 - Short_arm = [1, 0, 30; 0, 1, 0; 0, 0, 1];
3 - Long_arm = [1, 0, 60; 0, 1, 0; 0, 0, 1];
4 - R_75 = [cosd(75), -sind(75), 0; sind(75), cosd(75), 0; 0 0 1];
5 - R_minus60 = [cosd(-60), -sind(-60), 0; sind(-60), cosd(-60), 0; 0 0 1];
6
7 - Location = R_minus60 * Long_arm * R_75 * Short_arm * d;

```

```
>> Location
```

```
Location =
```

```

    58.9778
   -44.1970
     1.0000

```

The final location is $\begin{pmatrix} 58.98 \text{ cm} \\ -44.20 \text{ cm} \end{pmatrix}$

Part 2

```

1 - A = [4 8 -12 44; 3 6 -8 32; -2 -1 0 -7];
2   % 1
3 - A(1,:) == 0.25.*A(1,:)
4   % 2
5 - A(2,:) == A(2,:) - 3.*A(1,:)
6   % 3
7 - A(3,:) == 2.*A(1,:) + A(3,:)
8   % 4
9 - A([2 3],:) == A([3 2],:)
10  % 5
11 - A(2,:) == A(2,:)./3
12  % 6
13 - A(1,:) == A(1,:) - 2.*A(2,:)
14  % 7
15 - A(1,:) == A(1,:) - A(3,:)
16  % 8
17 - A(2,:) == A(2,:) + 2.*A(3,:)

```

Command Window

```
>> HW1_Part2
```

```
A =
```

```

     1     2    -3    11
     3     6    -8    32
    -2    -1     0    -7

```

```
A =
```

```

     1     2    -3    11
     0     0     1    -1
    -2    -1     0    -7

```

```
A =
```

```

     1     2    -3    11
     0     0     1    -1
     0     3    -6    15

```

```
A =
```

```

     1     2    -3    11
     0     3    -6    15
     0     0     1    -1

```

```
A =
```

```

     1     2    -3    11
     0     1    -2     5
     0     0     1    -1

```

```
A =
```

```

     1     0     1     1
     0     1    -2     5
     0     0     1    -1

```

```
A =
```

```

     1     0     0     2
     0     1    -2     5
     0     0     1    -1

```

```
A =
```

```

     1     0     0     2
     0     1     0     3
     0     0     1    -1

```

```
fx >>
```

Part 3

Command Window

Optimal solution found.

ans =

```

45.1546
-0.0082
0.1969

```

ans =

```

0
1.4534
0
-2.3954
0

```

linx =

```

0.6667
1.3333

```

quadx =

```

0.6667
1.3333

```

species =

```

2×1 cell array

    {'virginica' }
    {'versicolor'}

```

ans =

```

36.8218    29.6073   -12.9818    23.7147   -0.5532

```

ans =

```

-0.0170   -0.0161   -0.0171   -0.0191   -0.0200

```