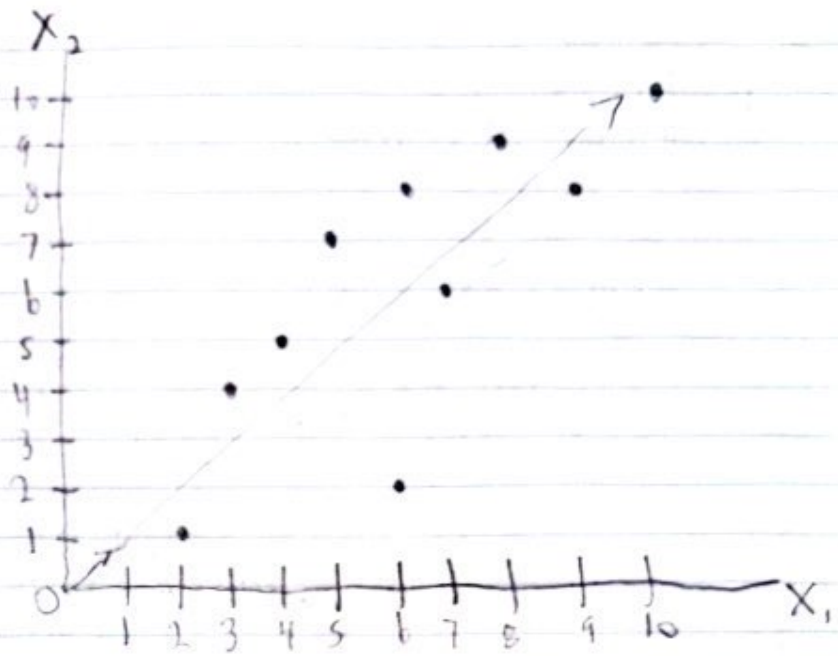
1.

X1	X2
3	4
5	7
6	2
8	9
7	6
4	5
9	8
2	1
10	10
6	8

2.



3. x_1 mean $= 3+5+6+8+7+4+9+2+10+6 = \frac{60}{10} = 6$

x_2 mean $= 4+7+2+9+6+5+8+1+10+8 = \frac{60}{10} = 6$

Centered Data

$x_1 - 6$	$x_2 - 6$
-3	-2
-1	1
0	-4
2	3
1	0
-2	-1
3	2
-4	-5
4	4
0	2

4.

$$Var(x_1) = \frac{9+1+0+4+1+4+9+16+16+0}{9} = 6.67$$

$$Var(x_2) = \frac{4+1+16+9+0+1+4+25+16+4}{9} = 8.89$$

$$Cov = \frac{6-1+0+6+0+2+6+20+16+0}{9} = 6.11$$

$$= \begin{bmatrix} 6.67 & 6.11 \\ 6.11 & 8.89 \end{bmatrix}$$

5. $\det\begin{bmatrix} 6.67-\lambda & 6.11 \\ 6.11 & 8.89-\lambda \end{bmatrix} = \dfrac{\det\begin{bmatrix} 60-\lambda & 55 \\ 55 & 80-\lambda \end{bmatrix}}{9}$

$= (60-\lambda)(80-\lambda)$

$\lambda^2 - 140\lambda + \underbrace{(80\times 60 - 55^2)}_{1775}$

$\lambda = \dfrac{140 \pm \sqrt{140^2 - 4(1)(1775)}}{2} \approx 111.8$

$\lambda'_1 \approx 125.9/9 = 14.00$

$\lambda'_2 \approx \dfrac{14.1}{9} = 1.57$

6. $(6.67-14)v_1 + 6.11v_2 \approx -7.33v_1 + 6.11v_2 = 0$

$v_2 \approx 1.2v_1$

$\sqrt{1^2+(1.2)^2} \approx \sqrt{1+1.44} \approx 1.56$

$v = (0.64, 0.77)$

7.

7/8

a: x_1, x_2	z: $x_1 \cdot 0.64 + x_2 \cdot 0.77$	z(a)
(-3, -2)	-3.46	(3.78, 3.37)
(-1, 1)	0.13	(6.08, 6.1)
(0, -4)	-3.08	(4.03, 3.63)
(2, 3)	3.59	(8.3, 5.76)
(1, 0)	0.64	(6.4, 6.5)
(-2, -1)	-2.05	(4.69, 4.42)
(3, 2)	3.46	(8.21, 6.66)
(-4, -5)	-6.41	(1.9, 1.06)
(4, 4)	5.64	(9.61, 10.34)
(0, 2)	1.54	(6.99, 7.19)

9. Plotted on original

10. Using PCA reduces data complexity by projecting 2D points onto a single line that captures most of the variation, this simplifies the dataset while keeping the main patterns and filtering out noise.