The phone brands OnePlus, Vivo and Oppo are owned by BBK Electronics. Table 4.1.G represents the data for the sales (in Lakhs) of OnePlus and BBK Electronics by different dealers in Chennai and Punjab in the year 2010. Based on the given information, answer questions (1), (2), (3), (4), (5) and (6).

Dealer's Location	OnePlus	BBK Electronics
Chennai	a	b
Punjab	c	d
Chennai	e	f
Punjab	g	h
Chennai	i	j
Punjab	k	l
Chennai	m	n

Table 4.1.G

Condition: $1 \leq a, c, e, g, i, k, m \leq 7$ and $10 \leq b, d, f, h, j, l, n \leq 20$

1. What is the population standard deviation of sales of OnePlus?
   Solution:
   Let m_x and σ_x be the mean and population standard deviation of sales of OnePlus respectively.
   $$m_x = \frac{a + c + e + g + i + k + m}{7}$$
   $$\sigma_x^2 = \frac{(a - m_x)^2 + (c - m_x)^2 + (e - m_x)^2 + (g - m_x)^2 + (i - m_x)^2 + (k - m_x)^2 + (m - m_x)^2}{7}$$
   Therefore, Population standard deviation of sales of OnePlus$= \sqrt{\sigma_x^2}$

2. What is the sample standard deviation of sales of BBK Electronics?
   Solution:
   Let m_y and S_y be the mean and sample standard deviation of sales of BBK Electronics respectively.
   $$m_y = \frac{b + d + f + h + j + l + n}{7}$$
   $$S_y^2 = \frac{(b - m_y)^2 + (d - m_y)^2 + (f - m_y)^2 + (h - m_y)^2 + (j - m_y)^2 + (l - m_y)^2 + (n - m_y)^2}{7 - 1}$$
   Therefore, Standard deviation of sales of BBK Electronics$= \sqrt{S_y^2}$

3. What is the sample co-variance between the sales of OnePlus and BBK Electronics?
   Solution:

Let X= Sales of OnePlus
Y= Sales of BBK Electronics.

Therefore, $Cov(X,Y) = \dfrac{\sum_{i=1}^{7}(x_i - m_x)(y_i - m_y)}{7 - 1}$

$= \dfrac{(a - m_x)(b - m_y) + (c - m_x)(d - m_y) + (e - m_x)(f - m_y) + (g - m_x)(h - m_y)}{6}$

$+ \dfrac{(i - m_x)(j - m_y) + (k - m_x)(l - m_y) + (m - m_x)(n - m_y)}{6}$

4. What is the correlation coefficient between the sales of OnePlus and BBK Electronics?
   Solution:
   Let r be the correlation coefficient between the sales of OnePlus and BBK Electronics.
   Therefore,

$$r = \frac{Cov(X,Y)}{S_x \times S_y}$$

   where,
   Cov(X,Y)= Sample Covariance between sales of OnePlus and BBK Electronics.

   S_x= Sample standard deviation of sales of OnePlus=$\sqrt{\dfrac{n}{n-1}}\sigma_x = \sqrt{\dfrac{7}{6}}\sigma_x$

   S_y= Sample standard deviation of sales of BBK Electronics.

5. What can you say about the linear relationship between the sales of OnePlus and BBK Electronics?

   a. Strong

   b. Positive

   c. Weak

   d. Negative

   e. Absence of linear relationship

   f. Moderate

   Solution: x
   If $0.75 \le r \le 1$, then there is a Strong and positive linear relationship between the sales of OnePlus and BBK Electronics.
   If $0.5 \le r < 0.75$, then there is a Moderate and positive linear relationship between the sales of OnePlus and BBK Electronics.
   If $0.25 \le r < 0.5$, then there is a Weak and positive linear relationship between the sales of OnePlus and BBK Electronics.
   If $-0.25 < r < 0.25$, then there is absence of linear relationship between the sales of OnePlus and BBK Electronics.
   If $-0.5 < r \le -0.25$, then there is a Weak and negative linear relationship between

the sales of OnePlus and BBK Electronics.

If $-0.75 < r \le -0.5$, then there is a Moderate and negative linear relationship between the sales of OnePlus and BBK Electronics.

If $-1 \le r \le -0.75$, then there is a Strong and negative linear relationship between the sales of OnePlus and BBK Electronics.

6. Is the sales of OnePlus strongly influenced by the location of dealer?

   a. Yes

   b. No

   Solution:
   Let Chennai be represented by 0 and Punjab by 1.
   The Point Bi-serial correlation coefficient between the sales of OnePlus and the location of dealer is given by:
   $$r_{pb} = \frac{(\bar{Y}_0 - \bar{Y}_1)}{\sigma_x} \times \sqrt{p_0 \times p_1}$$
   where, $p_0 = $ Proportion of Chennai dealers $= \dfrac{4}{7}$

   $p_1 = $ Proportion of Punjab dealers $= \dfrac{3}{7}$

   $\bar{Y}_0 = $ Mean sales of OnePlus in Chennai $= \dfrac{a + e + i + m}{4}$

   $\bar{Y}_1 = $ Mean sales of OnePlus in Punjab $= \dfrac{c + g + k}{3}$

   $\sigma_x = $ Population standard deviation of sales of OnePlus

   $$r_{pb} = \frac{(\bar{Y}_0 - \bar{Y}_1)}{\sigma_x} \times \sqrt{\frac{4}{7} \times \frac{3}{7}} = \frac{(\bar{Y}_0 - \bar{Y}_1)}{\sigma_x} \times 0.49487$$

   If $0.75 \le |r_{pb}| \le 1$, then the sales of OnePlus is strongly influenced by the location of dealer.
   Else, the sales of OnePlus is not strongly influenced by the location of dealer.

   N college students are classified according to their intelligence level and economic conditions and the results are given in Table 4.2.G.

Economic Conditions	Intelligence level			
	Bright	Average	Dull	Borderline
Good	a	b	c	d
Poor	e	f	g	h

Table 4.2.G

Based on the given information answer questions (7), (8), (9), (10) and (11).
Condition: $50 \leq a \leq 70$, $80 \leq b \leq 120$, $50 \leq c \leq 90$, $120 \leq d \leq 150$, $50 \leq e \leq 70$, $70 \leq f \leq 110$, $70 \leq g \leq 90$ and $70 \leq h \leq 110$

7. What proportion of total students are dull?
   Solution:
   Proportion of dull students $= \dfrac{c + g}{a + b + c + d + e + f + g + h}$.

8. What proportion of total students are poor economic conditions?
   Solution:
   Proportion of students having poor economic conditions $= \dfrac{e + f + g + h}{a + b + c + d + e + f + g + h}$.

9. What proportion of students of good economic conditions are borderline?
   Solution:
   Required proportion $= \dfrac{d}{a + b + c + d}$

10. What percentage of bright students are in poor economic conditions?
    Solution:
    Required percentage $= \left(\dfrac{e}{a + e} \right) \times 100$

11. What percentage of average students are in good economic conditions?
    Solution:
    Required percentage $= \left(\dfrac{b}{b + f} \right) \times 100$