EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 01

Time: 30 minutes | Maximum marks: 25

Name: _____ Class: _____ Date: _____

1. There are 25 questions. Each has exactly one correct answer: choose A, B, C or D.
2. Each correct answer carries 1 mark. There is no negative marking.
3. The key sheet and worked solutions are at the end of this test.

1. The rank of $\begin{bmatrix} 1 & 3 & 1 \\ 4 & 0 & 4 \\ -2 & 6 & -2 \end{bmatrix}$ is

A. 0 **B.** 3 **C.** 1 **D.** 2

2. If the matrix $\begin{bmatrix} 1 & -1 \\ 3 & k \end{bmatrix}$ has rank 1, then $k =$

A. $-\frac{1}{3}$ **B.** 3 **C.** -2 **D.** -3

3. The rank of the echelon matrix $\begin{bmatrix} -1 & -2 & 6 \\ 0 & 6 & -3 \\ 0 & 0 & -2 \\ 0 & 0 & 0 \end{bmatrix}$ is

A. 3 **B.** 2 **C.** 4 **D.** 1

4. The rank of the echelon matrix $\begin{bmatrix} 6 & -2 & 1 & 3 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ is

A. 1 **B.** 2 **C.** 4 **D.** 3

5. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 3 & -3 & -1 \\ 4 & -3 & -1 & 3 \\ 3 & -6 & 2 & 4 \end{bmatrix}$ is found to be

A. 2 **B.** 3 **C.** 4 **D.** 1

6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & -2 & 0 \\ -1 & 2 & 0 \\ -2 & 4 & 0 \end{bmatrix}$ is found to be

A. 3 **B.** 1 **C.** 2 **D.** 0

7. If A is a matrix of order 7×3, the greatest possible value of $\text{rank}(A)$ is

A. 7 **B.** 21 **C.** 3 **D.** 10

8. A and B are square matrices of order 8 with $\text{rank}(A) = 1$ and $\text{rank}(B) = 3$. The greatest possible value of $\text{rank}(A + B)$ is

A. 1 **B.** 4 **C.** 3 **D.** 8

9. The augmented matrix of the system $-4y = 5$, $4y - z = 11$ and $-4x + 3y = -2$ is

A. $\left[\begin{array}{ccc|c} -4 & 0 & 0 & 5 \\ 0 & 4 & -1 & 11 \\ -4 & 3 & 0 & -2 \end{array}\right]$

B. $\left[\begin{array}{ccc|c} 0 & -4 & 0 & 5 \\ 0 & 4 & -1 & 11 \\ -4 & 3 & 0 & -2 \end{array}\right]$

C. $\left[\begin{array}{ccc|c} 5 & -4 & 0 & 0 \\ 11 & 4 & -1 & 0 \\ -2 & 3 & 0 & -4 \end{array}\right]$

D. $\left[\begin{array}{ccc|c} 0 & -4 & 0 & -5 \\ 0 & 4 & -1 & -11 \\ -4 & 3 & 0 & 2 \end{array}\right]$

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10. The system $7x - 2y = -9$, $35x + ky = 10$ has no solution when $k =$

A. -2 **B.** 10 **C.** -10 **D.** $-\frac{2}{5}$

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11. The system $2x - y = -9$ and $4x - 2y = -18$ has

A. infinitely many solutions **B.** exactly two solutions

C. no solution **D.** a unique solution

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12. The homogeneous system $-4x + 4y = 0$, $-6x - 4y = 0$ has

A. exactly one non-zero solution **B.** infinitely many solutions

C. no solution **D.** only the trivial solution

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13. The system $3x + 2y = 0$, $6x + ky = 0$ has non-trivial solutions when $k =$

A. 1 **B.** -4 **C.** 4 **D.** 2

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14. The system $x - 2z = 0$, $3x - 2y - 2z = 0$ and $-2x + 3y + kz = 0$ has a non-trivial solution when $k =$

A. -2 **B.** -3 **C.** -1 **D.** 2

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15. The system $x - 7y - 2z = 0$, $x + ky + 2z = 0$ and $-x + y - z = 0$ has a non-trivial solution when $k =$

A. 0 **B.** 1 **C.** -1 **D.** 2

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16. For the system $x + y - z = 7$, $2x + y = 9$ and $-5x - 3y + z = -25$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

A. $(2, 2)$ **B.** $(3, 3)$ **C.** $(1, 2)$ **D.** $(2, 3)$

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17. For the system $x + z = -1$, $3x + 2y + 2z = -3$ and $-5x - 2y - 4z = 2$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

A. $(1, 2)$ **B.** $(2, 2)$ **C.** $(3, 3)$ **D.** $(2, 3)$

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18. For the system $2x - 3y = 10$, $-3x + 3y + 2z = -14$ and $-2x + 3y + z = -11$, the value of Δ in Cramer's rule is

A. 6 **B.** -6 **C.** -3 **D.** 3

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19. For the system $-2x + 4y + z = -8$, $-x - 3y = 4$ and $3x + 2y = 2$, the determinant Δ_3 used in Cramer's rule is

A. -28 **B.** -14 **C.** 28 **D.** 14

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20. The image of $(-5, 1)$ under reflection in the line $y = -x$ is

A. $(-1, 5)$ **B.** $(-5, -1)$ **C.** $(5, -1)$ **D.** $(1, -5)$

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21. The matrix of reflection in the y-axis is

A. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$ **B.** $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

C. $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

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22. The image of $(-9, -7)$ under reflection in the line $y = \frac{3}{2}x$ is

A. $(3, 11)$ **B.** $(\frac{129}{13}, -\frac{73}{13})$

C. $(-11, -3)$ **D.** $(-3, -11)$

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23. For reflection in the line $y = \frac{4}{3}x$, the entry $\cos 2\theta$ of the reflection matrix is

A. $-\frac{24}{25}$ **B.** $\frac{24}{25}$ **C.** $-\frac{7}{25}$ **D.** $\frac{7}{25}$

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24. When $(10, -7)$ is rotated anticlockwise about the origin through 240°, its image is

A. $(\frac{7}{2} - 5\sqrt{3}, -\frac{7\sqrt{3}}{2} - 5)$ **B.** $(5 + \frac{7\sqrt{3}}{2}, -\frac{7}{2} + 5\sqrt{3})$

C. $(-5 + \frac{7\sqrt{3}}{2}, \frac{7}{2} + 5\sqrt{3})$ **D.** $(-\frac{7\sqrt{3}}{2} - 5, \frac{7}{2} - 5\sqrt{3})$

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25. When $(-2, -9)$ is rotated anticlockwise about the origin through 210°, its image is

A. $(1 + \frac{9\sqrt{3}}{2}, -\frac{9}{2} + \sqrt{3})$ **B.** $(-\frac{9}{2} + \sqrt{3}, 1 + \frac{9\sqrt{3}}{2})$

C. $(\sqrt{3} + \frac{9}{2}, -1 + \frac{9\sqrt{3}}{2})$ **D.** $(\frac{9}{2} - \sqrt{3}, -\frac{9\sqrt{3}}{2} - 1)$

Key sheet

1. D	**2.** D	**3.** A	**4.** B	**5.** A
6. B	**7.** C	**8.** B	**9.** B	**10.** C
11. A	**12.** D	**13.** C	**14.** A	**15.** B
16. A	**17.** D	**18.** C	**19.** C	**20.** A
21. A	**22.** D	**23.** C	**24.** D	**25.** B

Solutions

1. The rank of $\begin{bmatrix} 1 & 3 & 1 \\ 4 & 0 & 4 \\ -2 & 6 & -2 \end{bmatrix}$ is

$|A| = 0$

A 2×2 submatrix $\begin{bmatrix} 1 & 3 \\ 4 & 0 \end{bmatrix}$ has determinant -12, so the rank is 2.

Ans: (D) 2

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2. If the matrix $\begin{bmatrix} 1 & -1 \\ 3 & k \end{bmatrix}$ has rank 1, then $k =$

Rank 1 means the matrix is singular: $k - (-1)(3) = 0$

$k = -3$

Ans: (D) -3

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3. The rank of the echelon matrix $\begin{bmatrix} -1 & -2 & 6 \\ 0 & 6 & -3 \\ 0 & 0 & -2 \\ 0 & 0 & 0 \end{bmatrix}$ is

The matrix is in echelon form, so its rank is the number of non-zero rows.

$\text{rank} = 3$

Ans: (A) 3

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4. The rank of the echelon matrix $\begin{bmatrix} 6 & -2 & 1 & 3 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ is

The matrix is in echelon form, so its rank is the number of non-zero rows.

$\text{rank} = 2$

Ans: (B) 2

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5. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 3 & -3 & -1 \\ 4 & -3 & -1 & 3 \\ 3 & -6 & 2 & 4 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 - 4R_1$, $R_3 \to R_3 - 3R_1$: $A \sim \begin{bmatrix} 1 & 3 & -3 & -1 \\ 0 & -15 & 11 & 7 \\ 0 & -15 & 11 & 7 \end{bmatrix}$

Apply $R_3 \to R_3 - R_2$: $\sim \begin{bmatrix} 1 & 3 & -3 & -1 \\ 0 & -15 & 11 & 7 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

Number of non-zero rows $= 2$, so the rank is 2.

Ans: (A) 2

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6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & -2 & 0 \\ -1 & 2 & 0 \\ -2 & 4 & 0 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 + R_1$, $R_3 \to R_3 + 2R_1$: $A \sim \begin{bmatrix} 1 & -2 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

Number of non-zero rows $= 1$, so the rank is 1.

Ans: (B) 1

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7. If A is a matrix of order 7×3, the greatest possible value of $\text{rank}(A)$ is

For an $m \times n$ matrix, $\text{rank} \le \min(m, n)$.

$\min(7, 3) = 3$

Ans: (C) 3

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8. A and B are square matrices of order 8 with $\text{rank}(A) = 1$ and $\text{rank}(B) = 3$. The greatest possible value of $\text{rank}(A + B)$ is

$\text{rank}(A + B) \le \text{rank}(A) + \text{rank}(B)$.

$1 + 3 = 4$

Ans: (B) 4

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9. The augmented matrix of the system $-4y = 5$, $4y - z = 11$ and $-4x + 3y = -2$ is

Write the coefficients of x, y, z in order (a missing variable has coefficient 0), then the constant.

$[A \,|\, B] = \left[\begin{array}{ccc|c} 0 & -4 & 0 & 5 \\ 0 & 4 & -1 & 11 \\ -4 & 3 & 0 & -2 \end{array}\right]$

Ans: (B) $\left[\begin{array}{ccc|c} 0 & -4 & 0 & 5 \\ 0 & 4 & -1 & 11 \\ -4 & 3 & 0 & -2 \end{array}\right]$

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10. The system $7x - 2y = -9$, $35x + ky = 10$ has no solution when $k =$

$\frac{7}{35} = \frac{-2}{k}$ (and the constants are not in this ratio)

$k = -10$

Ans: (C) -10

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11. The system $2x - y = -9$ and $4x - 2y = -18$ has

$\frac{a_1}{a_2} = \frac{2}{4}$, $\frac{b_1}{b_2} = \frac{-1}{-2}$, $\frac{c_1}{c_2} = \frac{-9}{-18}$

$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$: the lines coincide.

Ans: (A) infinitely many solutions

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12. The homogeneous system $-4x + 4y = 0$, $-6x - 4y = 0$ has

$|A| = 40$

$|A| \neq 0$, so only $x = y = 0$.

Ans: (D) only the trivial solution

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13. The system $3x + 2y = 0$, $6x + ky = 0$ has non-trivial solutions when $k =$

$\frac{3}{6} = \frac{2}{k}$

$k = 4$

Ans: (C) 4

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14. The system $x - 2z = 0$, $3x - 2y - 2z = 0$ and $-2x + 3y + kz = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $-2k - 4 = 0$

$k = -2$

Ans: (A) -2

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15. The system $x - 7y - 2z = 0$, $x + ky + 2z = 0$ and $-x + y - z = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $3 - 3k = 0$

$k = 1$

Ans: (B) 1

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16. For the system $x + y - z = 7$, $2x + y = 9$ and $-5x - 3y + z = -25$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 + 2R_2$: $\sim \left[\begin{array}{ccc|c} 1 & 1 & -1 & 7 \\ 0 & -1 & 2 & -5 \\ 0 & 0 & 0 & 0 \end{array}\right]$

Coefficient part: 2 non-zero rows; whole matrix: 2.

Ans: (A) $(2, 2)$

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17. For the system $x + z = -1$, $3x + 2y + 2z = -3$ and $-5x - 2y - 4z = 2$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 + R_2$: $\sim \left[\begin{array}{ccc|c} 1 & 0 & 1 & -1 \\ 0 & 2 & -1 & 0 \\ 0 & 0 & 0 & -3 \end{array}\right]$

Coefficient part: 2 non-zero rows; whole matrix: 3.

Ans: (D) $(2, 3)$

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18. For the system $2x - 3y = 10$, $-3x + 3y + 2z = -14$ and $-2x + 3y + z = -11$, the value of Δ in Cramer's rule is

$\Delta = 2(3 - 6) + 3(-3 + 4) + 0(-9 + 6) = -3$

Ans: (C) -3

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19. For the system $-2x + 4y + z = -8$, $-x - 3y = 4$ and $3x + 2y = 2$, the determinant Δ_3 used in Cramer's rule is

Replace column 3 of A by the constants: $\Delta_3 = \begin{vmatrix} -2 & 4 & -8 \\ -1 & -3 & 4 \\ 3 & 2 & 2 \end{vmatrix}$

$= -2(-6 - 8) - 4(-2 - 12) - 8(-2 + 9) = 28$

Ans: (C) 28

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20. The image of $(-5, 1)$ under reflection in the line $y = -x$ is

$$\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} -5 \\ 1 \end{bmatrix} = \begin{bmatrix} -1 \\ 5 \end{bmatrix}$$

Ans: (A) $(-1, 5)$

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21. The matrix of reflection in the y-axis is

Reflection in the y-axis sends $(x, y) \mapsto (-x, y)$, so the matrix is $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$.

Ans: (A) $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

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22. The image of $(-9, -7)$ under reflection in the line $y = \frac{3}{2}x$ is

Reflection matrix $\begin{bmatrix} -\frac{5}{13} & \frac{12}{13} \\ \frac{12}{13} & \frac{5}{13} \end{bmatrix}$

Image $(-3, -11)$

Ans: (D) $(-3, -11)$

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23. For reflection in the line $y = \frac{4}{3}x$, the entry $\cos 2\theta$ of the reflection matrix is

$\cos 2\theta = \frac{1-\tan^2\theta}{1+\tan^2\theta} = \frac{1-(\frac{4}{3})^2}{1+(\frac{4}{3})^2} = -\frac{7}{25}$

Ans: (C) $-\frac{7}{25}$

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24. When $(10, -7)$ is rotated anticlockwise about the origin through $240°$, its image is

$$\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} 10 \\ -7 \end{bmatrix} = \begin{bmatrix} -\frac{7\sqrt{3}}{2} - 5 \\ \frac{7}{2} - 5\sqrt{3} \end{bmatrix}$$

Ans: (D) $(-\frac{7\sqrt{3}}{2} - 5, \frac{7}{2} - 5\sqrt{3})$

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25. When $(-2, -9)$ is rotated anticlockwise about the origin through $210°$, its image is

$$\begin{bmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} -2 \\ -9 \end{bmatrix} = \begin{bmatrix} -\frac{9}{2} + \sqrt{3} \\ 1 + \frac{9\sqrt{3}}{2} \end{bmatrix}$$

Ans: (B) $(-\frac{9}{2} + \sqrt{3}, 1 + \frac{9\sqrt{3}}{2})$
