EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 07

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 $\begin{bmatrix} 1 & 2 & 4 \\ -2 & -4 & -8 \\ -2 & -4 & -8 \end{bmatrix}$ is

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

2. The rank of $\begin{bmatrix} 1 & 3 & 2 \\ 4 & 3 & 1 \\ -10 & -12 & -6 \end{bmatrix}$ is

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

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

A. 3 **B.** 1 **C.** 5 **D.** 2

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

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

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

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

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

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

7. A matrix A of order 4×3 has rank 1. Then $\operatorname{rank}(A^T) =$

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

8. If A is a square matrix of order 5 with $\det A = -6$, then $\operatorname{rank}(A) =$

A. 4 **B.** 5 **C.** 1 **D.** 0

9. The augmented matrix of the system $-2y = 5$, $-2x + 2y - 3z = -8$ and $5x + 3y + 5z = 11$ is

A. $\left[\begin{array}{ccc|c} 0 & -2 & 0 & -5 \\ -2 & 2 & -3 & 8 \\ 5 & 3 & 5 & -11 \end{array}\right]$

B. $\left[\begin{array}{ccc|c} 5 & -2 & 0 & 0 \\ -8 & 2 & -3 & -2 \\ 11 & 3 & 5 & 5 \end{array}\right]$

C. $\left[\begin{array}{ccc|c} -2 & 0 & 0 & 5 \\ -2 & 2 & -3 & -8 \\ 5 & 3 & 5 & 11 \end{array}\right]$

D. $\left[\begin{array}{ccc|c} 0 & -2 & 0 & 5 \\ -2 & 2 & -3 & -8 \\ 5 & 3 & 5 & 11 \end{array}\right]$

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10. The system $4x - 2y = -1$, $12x + ky = 7$ has no solution when $k =$

A. 6 **B.** $-\frac{2}{3}$ **C.** -6 **D.** -2

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11. The solution of $-x - 2y = 0$ and $2x - 4y = 24$ is

A. $x = 6,\ y = -3$ **B.** $x = -3,\ y = 6$ **C.** $x = -6,\ y = -3$ **D.** $x = 6,\ y = 3$

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12. The system $4x - y = 0$, $24x + ky = 0$ has non-trivial solutions when $k =$

A. -1 **B.** $-\frac{1}{6}$ **C.** 6 **D.** -6

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13. The system $5x + 4y = 0$, $25x + ky = 0$ has non-trivial solutions when $k =$

A. $\frac{4}{5}$ **B.** 4 **C.** 20 **D.** -20

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14. The system $5x - 3y + 6z = 0$, $-4x + y - 9z = 0$ and $kx + 2y - 3z = 0$ has a non-trivial solution when $k =$

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

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15. The system $x - 2y - 3z = 0$, $kx - 5y - 3z = 0$ and $2x + 5y - 6z = 0$ has a non-trivial solution when $k =$

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

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16. A system $AX = B$ in 3 unknowns has $\text{rank}(A) = 3$ and $\text{rank}[A \mid B] = 4$. The system

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

C. is inconsistent **D.** has a unique solution

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17. For the system $x + y - z = -1$, $3x + 4z = 2$ and $-8x - 2y - 6z = 5$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

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

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18. For the system $-x - y + z = -3$, $4x + 4y - 3z = 11$ and $3x + 4y + 4z = 1$, the value of Δ in Cramer's rule is

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

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19. For the system $-x = -2$, $4x + 2y - 2z = -2$ and $4x - 3y - 2z = 8$, the determinant Δ_2 used in Cramer's rule is

A. 20 **B.** 30 **C.** -20 **D.** 10

20. The matrix of reflection in the x-axis is

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

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

21. The image of $(-9, -4)$ under reflection in the origin is

A. $(-4, -9)$ **B.** $(4, 9)$ **C.** $(9, 4)$ **D.** $(9, -4)$

22. For reflection in the line $y = -\frac{1}{3}x$, the entry $\cos 2\theta$ of the reflection matrix is

A. $\frac{4}{5}$ **B.** $\frac{3}{5}$ **C.** $-\frac{3}{5}$ **D.** $-\frac{4}{5}$

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

A. $(-\frac{74}{13}, \frac{59}{13})$ **B.** $(-\frac{59}{13}, \frac{74}{13})$

C. $(\frac{74}{13}, -\frac{59}{13})$ **D.** $(-\frac{94}{13}, \frac{11}{13})$

24. When $(2, 4)$ is rotated anticlockwise about the origin through $120°$, its image is

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

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

25. When $(-7, 5)$ is rotated anticlockwise about the origin through $90°$, its image is

A. $(-5, -7)$ **B.** $(-7, -5)$ **C.** $(-5, 7)$ **D.** $(5, 7)$

Key sheet

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

Solutions

1. The rank of $\begin{bmatrix} 1 & 2 & 4 \\ -2 & -4 & -8 \\ -2 & -4 & -8 \end{bmatrix}$ is

$|A| = 0$

All rows are multiples of one row, so every 2×2 minor is 0: rank 1.

Ans: (B) 1

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2. The rank of $\begin{bmatrix} 1 & 3 & 2 \\ 4 & 3 & 1 \\ -10 & -12 & -6 \end{bmatrix}$ is

$|A| = 0$

A 2×2 submatrix $\begin{bmatrix} 1 & 3 \\ 4 & 3 \end{bmatrix}$ has determinant -9, so the rank is 2.

Ans: (A) 2

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

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

$\text{rank} = 2$

Ans: (D) 2

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

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

$\text{rank} = 3$

Ans: (A) 3

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

Apply $R_2 \to R_2 + 2R_1$: $A \sim \begin{bmatrix} 1 & -1 & -3 \\ 0 & 0 & 0 \end{bmatrix}$

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

Ans: (B) 1

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

Apply $R_2 \to R_2 + R_1$: $A \sim \begin{bmatrix} 1 & -2 & 3 \\ 0 & 0 & 0 \end{bmatrix}$

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

Ans: (A) 1

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7. A matrix A of order 4×3 has rank 1. Then $\text{rank}(A^T) =$

$\text{rank}(A^T) = \text{rank}(A)$.

$\text{rank}(A^T) = 1$

Ans: (B) 1

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8. If A is a square matrix of order 5 with $\det A = -6$, then $\text{rank}(A) =$

$\det A \neq 0$, so A is non-singular.

A non-singular matrix of order n has rank n: here 5.

Ans: (B) 5

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9. The augmented matrix of the system $-2y = 5$, $-2x + 2y - 3z = -8$ and $5x + 3y + 5z = 11$ is

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

$$[A \mid B] = \left[\begin{array}{ccc|c} 0 & -2 & 0 & 5 \\ -2 & 2 & -3 & -8 \\ 5 & 3 & 5 & 11 \end{array}\right]$$

Ans: (D) $\left[\begin{array}{ccc|c} 0 & -2 & 0 & 5 \\ -2 & 2 & -3 & -8 \\ 5 & 3 & 5 & 11 \end{array}\right]$

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10. The system $4x - 2y = -1$, $12x + ky = 7$ has no solution when $k =$

$\frac{4}{12} = \frac{-2}{k}$ (and the constants are not in this ratio)

$k = -6$

Ans: (C) -6

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11. The solution of $-x - 2y = 0$ and $2x - 4y = 24$ is

Eliminate one variable and substitute back.

$x = 6,\ y = -3$

Ans: (A) $x = 6,\ y = -3$

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12. The system $4x - y = 0$, $24x + ky = 0$ has non-trivial solutions when $k =$

$\frac{4}{24} = \frac{-1}{k}$

$k = -6$

Ans: (D) -6

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13. The system $5x + 4y = 0$, $25x + ky = 0$ has non-trivial solutions when $k =$

$\frac{5}{25} = \frac{4}{k}$

$k = 20$

Ans: (C) 20

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14. The system $5x - 3y + 6z = 0$, $-4x + y - 9z = 0$ and $kx + 2y - 3z = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $21k + 63 = 0$

$k = -3$

Ans: (B) -3

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15. The system $x - 2y - 3z = 0$, $kx - 5y - 3z = 0$ and $2x + 5y - 6z = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $27 - 27k = 0$

$k = 1$

Ans: (B) 1

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16. A system $AX = B$ in 3 unknowns has $\text{rank}(A) = 3$ and $\text{rank}[A \mid B] = 4$. The system

Unequal ranks: inconsistent. Equal ranks $= n$: unique solution. Equal ranks $< n$: infinitely many. Here the system is inconsistent.

Ans: (C) is inconsistent

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17. For the system $x + y - z = -1$, $3x + 4z = 2$ and $-8x - 2y - 6z = 5$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 + 2R_2$: $\sim \left[\begin{array}{ccc|c} 1 & 1 & -1 & -1 \\ 0 & -3 & 7 & 5 \\ 0 & 0 & 0 & 7 \end{array}\right]$

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

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

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18. For the system $-x - y + z = -3$, $4x + 4y - 3z = 11$ and $3x + 4y + 4z = 1$, the value of Δ in Cramer's rule is

$\Delta = -(16 + 12) + (16 + 9) + (16 - 12) = 1$

Ans: (D) 1

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19. For the system $-x = -2$, $4x + 2y - 2z = -2$ and $4x - 3y - 2z = 8$, the determinant Δ_2 used in Cramer's rule is

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} -1 & -2 & 0 \\ 4 & -2 & -2 \\ 4 & 8 & -2 \end{vmatrix}$

$= -(4 + 16) + 2(-8 + 8) + 0(32 + 8) = -20$

Ans: (C) -20

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20. The matrix of reflection in the x-axis is

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

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

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21. The image of $(-9, -4)$ under reflection in the origin is

$\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} -9 \\ -4 \end{bmatrix} = \begin{bmatrix} 9 \\ 4 \end{bmatrix}$

Ans: (C) $(9, 4)$

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22. For reflection in the line $y = -\frac{1}{3}x$, the entry $\cos 2\theta$ of the reflection matrix is

$\cos 2\theta = \frac{1-\tan^2\theta}{1+\tan^2\theta} = \frac{1-(-\frac{1}{3})^2}{1+(-\frac{1}{3})^2} = \frac{4}{5}$

Ans: (A) $\frac{4}{5}$

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

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

Image $(\frac{74}{13}, -\frac{59}{13})$

Ans: (C) $(\frac{74}{13}, -\frac{59}{13})$

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24. When $(2, 4)$ is rotated anticlockwise about the origin through $120°$, its image is

$$\begin{bmatrix} -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} 2 \\ 4 \end{bmatrix} = \begin{bmatrix} -2\sqrt{3} - 1 \\ -2 + \sqrt{3} \end{bmatrix}$$

Ans: (D) $(-2\sqrt{3} - 1, -2 + \sqrt{3})$

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25. When $(-7, 5)$ is rotated anticlockwise about the origin through $90°$, its image is

$$\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} -7 \\ 5 \end{bmatrix} = \begin{bmatrix} -5 \\ -7 \end{bmatrix}$$

Ans: (A) $(-5, -7)$
