EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 04

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 $\begin{bmatrix} 2 & 3 & -2 \\ -1 & 0 & 0 \\ -3 & 3 & 3 \end{bmatrix}$ is

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

2. If the matrix $\begin{bmatrix} 2 & 2 \\ 4 & k \end{bmatrix}$ has rank 1, then $k =$

A. 4 **B.** 6 **C.** -4 **D.** 1

3. Is the matrix $\begin{bmatrix} 0 & 1 & 4 & 3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & -3 \end{bmatrix}$ in echelon form?

A. No: two non-zero rows begin with the same number of zeros

B. No: a zero row lies above a non-zero row

C. No: a row begins with fewer zeros than the row above it

D. Yes, and its rank is 2

4. Is the matrix $\begin{bmatrix} -1 & -2 & 6 \\ 0 & 0 & 0 \\ 0 & 5 & 5 \end{bmatrix}$ in echelon form?

A. No: a zero row lies above a non-zero row

B. No: a row begins with fewer zeros than the row above it

C. No: two non-zero rows begin with the same number of zeros

D. Yes, and its rank is 2

5. To reduce $A = \begin{bmatrix} 2 & -4 & 6 \\ 3 & 1 & -4 \\ 6 & 3 & 0 \end{bmatrix}$ to echelon form, which of the following operations is NOT an elementary transformation?

A. $C_1 \leftrightarrow C_2$ **B.** $R_1 \to R_1^2$

C. $R_2 \to R_2 + 2R_1$ **D.** $R_1 \to 2R_1$

6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & -3 & -2 & -2 \\ -1 & -1 & 2 & 1 \\ 0 & 4 & 0 & 1 \end{bmatrix}$ is found to be

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

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

A. 0 **B.** 4 **C.** 3 **D.** 7

8. The rank of the identity matrix I_4 is

A. 1 **B.** 16 **C.** 0 **D.** 4

9. The augmented matrix of the system $-3y + z = -8$, $-3x - y - 5z = -8$ and $-5x + 6y = 7$ is

A. $\left[\begin{array}{ccc|c} -3 & 1 & 0 & -8 \\ -3 & -1 & -5 & -8 \\ -5 & 6 & 0 & 7 \end{array}\right]$

B. $\left[\begin{array}{ccc|c} 0 & -3 & 1 & -8 \\ -3 & -1 & -5 & -8 \\ -5 & 6 & 0 & 7 \end{array}\right]$

C. $\left[\begin{array}{ccc|c} -8 & -3 & 1 & 0 \\ -8 & -1 & -5 & -3 \\ 7 & 6 & 0 & -5 \end{array}\right]$

D. $\left[\begin{array}{ccc|c} 0 & -3 & 1 & 8 \\ -3 & -1 & -5 & 8 \\ -5 & 6 & 0 & -7 \end{array}\right]$

10. The solution of $7x + 4y = -24$ and $-x + 2y = 6$ is

A. $x = 1,\ y = -4$ **B.** $x = 4,\ y = 1$ **C.** $x = -4,\ y = -1$ **D.** $x = -4,\ y = 1$

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

A. no solution **B.** a unique solution
C. infinitely many solutions **D.** exactly two solutions

12. The homogeneous system $-3x - 3y = 0$, $5x - 3y = 0$ has

A. only the trivial solution **B.** exactly one non-zero solution
C. no solution **D.** infinitely many solutions

13. The homogeneous system $-2x - 5y = 0$, $7x + 4y = 0$ has

A. infinitely many solutions **B.** exactly one non-zero solution
C. no solution **D.** only the trivial solution

14. The system $7x - 4y - 6z = 0$, $x + 2y = 0$ and $-2x + ky + 3z = 0$ has a non-trivial solution when $k =$

A. 4 **B.** -5 **C.** 5 **D.** 6

15. The system $y - z = 0$, $-x + ky - 3z = 0$ and $-3x - 2y - 4z = 0$ has a non-trivial solution when $k =$

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

16. For the system $x + 2y - z = -2$, $6x + 4y - 4z = 0$ and $4x + 4y - 3z = 2$, 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 $x - 3y - z = -9$, $y - z = 4$ and $-x + 2y + 2z = 5$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

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

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18. For the system $-x - z = -6$, $x + y - 2z = -3$ and $x - 2y + z = 6$, the determinant Δ_2 used in Cramer's rule is

A. 18 **B.** 2 **C.** 0 **D.** 6

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19. For the system $-x - 2y + 4z = 14$, $-x + y + 2z = 12$ and $-x + y + 3z = 16$, the determinant Δ_3 used in Cramer's rule is

A. -6 **B.** 12 **C.** 6 **D.** -12

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20. The image of $(1, 6)$ under reflection in the origin is

A. $(-1, -6)$ **B.** $(-1, 6)$ **C.** $(6, 1)$ **D.** $(-6, -1)$

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21. The image of $(2, 8)$ under reflection in the origin is

A. $(-2, 8)$ **B.** $(8, 2)$ **C.** $(-8, -2)$ **D.** $(-2, -8)$

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22. The matrix of reflection in the line $y = -\frac{1}{3}x$ is

A. $\begin{bmatrix} -\frac{3}{5} & \frac{4}{5} \\ \frac{4}{5} & \frac{3}{5} \end{bmatrix}$

B. $\begin{bmatrix} \frac{4}{5} & \frac{3}{5} \\ -\frac{3}{5} & \frac{4}{5} \end{bmatrix}$

C. $\begin{bmatrix} \frac{4}{5} & -\frac{3}{5} \\ -\frac{3}{5} & -\frac{4}{5} \end{bmatrix}$

D. $\begin{bmatrix} -\frac{4}{5} & -\frac{3}{5} \\ -\frac{3}{5} & \frac{4}{5} \end{bmatrix}$

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

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

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24. When $(5, 10)$ is rotated anticlockwise about the origin through 240°, its image is

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

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

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25. When $(10, -8)$ is rotated anticlockwise about the origin through 120°, its image is

A. $(-5 + 4\sqrt{3}, 4 + 5\sqrt{3})$ **B.** $(-4\sqrt{3} - 5, 4 - 5\sqrt{3})$

C. $(4 + 5\sqrt{3}, -5 + 4\sqrt{3})$ **D.** $(5 - 4\sqrt{3}, -5\sqrt{3} - 4)$

Key sheet

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

Solutions

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

$|A| = 15$

$|A| \neq 0$, so the rank is 3.

Ans: (C) 3

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2. If the matrix $\begin{bmatrix} 2 & 2 \\ 4 & k \end{bmatrix}$ has rank 1, then $k =$

Rank 1 means the matrix is singular: $2k - (2)(4) = 0$

$k = 4$

Ans: (A) 4

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3. Is the matrix $\begin{bmatrix} 0 & 1 & 4 & 3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & -3 \end{bmatrix}$ in echelon form?

Zeros before the first non-zero entry, row by row: 1, none (zero row), 2.

Echelon form needs this count to increase down the rows, with zero rows at the bottom. No: a zero row lies above a non-zero row.

Ans: (B) No: a zero row lies above a non-zero row

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4. Is the matrix $\begin{bmatrix} -1 & -2 & 6 \\ 0 & 0 & 0 \\ 0 & 5 & 5 \end{bmatrix}$ in echelon form?

Zeros before the first non-zero entry, row by row: 0, none (zero row), 1.

Echelon form needs this count to increase down the rows, with zero rows at the bottom. No: a zero row lies above a non-zero row.

Ans: (A) No: a zero row lies above a non-zero row

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5. To reduce $A = \begin{bmatrix} 2 & -4 & 6 \\ 3 & 1 & -4 \\ 6 & 3 & 0 \end{bmatrix}$ to echelon form, which of the following operations is NOT an elementary transformation?

The elementary transformations are: interchange two rows (or columns), multiply a row by a non-zero number, add a multiple of another row.

$R_1 \to R_1^2$ is none of these, so it can change the rank.

Ans: (B) $R_1 \to R_1^2$

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6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & -3 & -2 & -2 \\ -1 & -1 & 2 & 1 \\ 0 & 4 & 0 & 1 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 + R_1$: $A \sim \begin{bmatrix} 1 & -3 & -2 & -2 \\ 0 & -4 & 0 & -1 \\ 0 & 4 & 0 & 1 \end{bmatrix}$

Apply $R_3 \to R_3 + R_2$: $\sim \begin{bmatrix} 1 & -3 & -2 & -2 \\ 0 & -4 & 0 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

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

Ans: (B) 2

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

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

$\text{rank}(A^T) = 3$

Ans: (C) 3

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8. The rank of the identity matrix I_4 is

I_4 is in echelon form with 4 non-zero rows.

$\text{rank}(I_4) = 4$

Ans: (D) 4

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9. The augmented matrix of the system $-3y + z = -8$, $-3x - y - 5z = -8$ and $-5x + 6y = 7$ is

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

$[A \mid B] = \left[\begin{array}{ccc|c} 0 & -3 & 1 & -8 \\ -3 & -1 & -5 & -8 \\ -5 & 6 & 0 & 7 \end{array}\right]$

Ans: (B) $\left[\begin{array}{ccc|c} 0 & -3 & 1 & -8 \\ -3 & -1 & -5 & -8 \\ -5 & 6 & 0 & 7 \end{array}\right]$

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10. The solution of $7x + 4y = -24$ and $-x + 2y = 6$ is

Eliminate one variable and substitute back.

$x = -4,\ y = 1$

Ans: (D) $x = -4,\ y = 1$

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

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

$\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$: parallel lines, no solution.

Ans: (A) no solution

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12. The homogeneous system $-3x - 3y = 0$, $5x - 3y = 0$ has

$|A| = 24$

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

Ans: (A) only the trivial solution

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13. The homogeneous system $-2x - 5y = 0$, $7x + 4y = 0$ has

$|A| = 27$

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

Ans: (D) only the trivial solution

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14. The system $7x - 4y - 6z = 0$, $x + 2y = 0$ and $-2x + ky + 3z = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $30 - 6k = 0$

$k = 5$

Ans: (C) 5

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15. The system $y - z = 0$, $-x + ky - 3z = 0$ and $-3x - 2y - 4z = 0$ has a non-trivial solution when $k =$

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

$k = 1$

Ans: (C) 1

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16. For the system $x + 2y - z = -2$, $6x + 4y - 4z = 0$ and $4x + 4y - 3z = 2$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 - 2R_2$: $\sim \left[\begin{array}{ccc|c} 1 & 2 & -1 & -2 \\ 0 & -4 & 1 & 10 \\ 0 & 0 & 0 & -8 \end{array}\right]$

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

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

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17. For the system $x - 3y - z = -9$, $y - z = 4$ and $-x + 2y + 2z = 5$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 + R_2$: $\sim \left[\begin{array}{ccc|c} 1 & -3 & -1 & -9 \\ 0 & 1 & -1 & 4 \\ 0 & 0 & 0 & 0 \end{array}\right]$

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

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

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18. For the system $-x - z = -6$, $x + y - 2z = -3$ and $x - 2y + z = 6$, the determinant Δ_2 used in Cramer's rule is

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} -1 & -6 & -1 \\ 1 & -3 & -2 \\ 1 & 6 & 1 \end{vmatrix}$

$= -(-3 + 12) + 6(1 + 2) - (6 + 3) = 0$

Ans: (C) 0

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19. For the system $-x-2y+4z=14$, $-x+y+2z=12$ and $-x+y+3z=16$, the determinant Δ_3 used in Cramer's rule is

Replace column 3 of A by the constants: $\Delta_3=\begin{vmatrix}-1 & -2 & 14\\ -1 & 1 & 12\\ -1 & 1 & 16\end{vmatrix}$

$=-(16-12)+2(-16+12)+14(-1+1)=-12$

Ans: (D) -12

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20. The image of $(1,6)$ under reflection in the origin is

$\begin{bmatrix}-1 & 0\\ 0 & -1\end{bmatrix}\begin{bmatrix}1\\6\end{bmatrix}=\begin{bmatrix}-1\\-6\end{bmatrix}$

Ans: (A) $(-1,-6)$

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21. The image of $(2,8)$ under reflection in the origin is

$\begin{bmatrix}-1 & 0\\ 0 & -1\end{bmatrix}\begin{bmatrix}2\\8\end{bmatrix}=\begin{bmatrix}-2\\-8\end{bmatrix}$

Ans: (D) $(-2,-8)$

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22. The matrix of reflection in the line $y=-\frac{1}{3}x$ is

$m=-\frac{1}{3}:\ \frac{1-m^2}{1+m^2}=\frac{4}{5},\ \frac{2m}{1+m^2}=-\frac{3}{5}$

$\begin{bmatrix}\frac{4}{5} & -\frac{3}{5}\\ -\frac{3}{5} & -\frac{4}{5}\end{bmatrix}$

Ans: (C) $\begin{bmatrix}\frac{4}{5} & -\frac{3}{5}\\ -\frac{3}{5} & -\frac{4}{5}\end{bmatrix}$

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

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

Ans: (C) $-\frac{4}{5}$

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24. When $(5,10)$ is rotated anticlockwise about the origin through 240°, its image is

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

Ans: (B) $(-\frac{5}{2}+5\sqrt{3},-5-\frac{5\sqrt{3}}{2})$

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25. When $(10,-8)$ is rotated anticlockwise about the origin through 120°, its image is

$\begin{bmatrix}-\frac{1}{2} & -\frac{\sqrt{3}}{2}\\ \frac{\sqrt{3}}{2} & -\frac{1}{2}\end{bmatrix}\begin{bmatrix}10\\-8\end{bmatrix}=\begin{bmatrix}-5+4\sqrt{3}\\ 4+5\sqrt{3}\end{bmatrix}$

Ans: (A) $(-5+4\sqrt{3},4+5\sqrt{3})$
