EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 02

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. If the matrix $\begin{bmatrix} 2 & -3 \\ -6 & k \end{bmatrix}$ has rank 1, then $k =$

A. 9 **B.** 4 **C.** -9 **D.** 1

2. For $A = \begin{bmatrix} 1 & 6 & -2 \\ 5 & -1 & 1 \\ 5 & 1 & 5 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 2 and column 3 is

A. -29 **B.** 29 **C.** 31 **D.** -31

3. Is the matrix $\begin{bmatrix} 0 & 1 & 4 \\ 5 & 1 & -3 \\ 0 & 0 & 1 \end{bmatrix}$ 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. Yes, and its rank is 3

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

4. Is the matrix $\begin{bmatrix} -2 & -3 & -3 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 6 & -2 \end{bmatrix}$ in echelon form?

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

B. Yes, and its rank is 2

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

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

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

A. $R_3 \to R_3 \cdot R_2$ **B.** $C_3 \leftrightarrow C_2$

C. $R_3 \to -3R_3$ **D.** $R_3 \leftrightarrow R_2$

6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 4 & 3 \\ -2 & -8 & -6 \end{bmatrix}$ is found to be

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

7. If $\text{rank}(A) = 2$, $\text{rank}(B) = 5$ and AB is defined, the greatest possible value of $\text{rank}(AB)$ is

A. 7 **B.** 2 **C.** 10 **D.** 5

8. If A is a square matrix of order 7 with $\det A = 4$, then $\text{rank}(A) =$

A. 7 **B.** 6 **C.** 1 **D.** 0

9. The augmented matrix of the system $-2x + 3y + 5z = 9$, $x - z = 11$ and $-2y + z = 6$ is

A. $\left[\begin{array}{ccc|c} 9 & 3 & 5 & -2 \\ 11 & 0 & -1 & 1 \\ 6 & -2 & 1 & 0 \end{array}\right]$

B. $\left[\begin{array}{ccc|c} -2 & 3 & 5 & 9 \\ 1 & 0 & -1 & 11 \\ 0 & -2 & 1 & 6 \end{array}\right]$

C. $\left[\begin{array}{ccc|c} -2 & 3 & 5 & 9 \\ 1 & -1 & 0 & 11 \\ 0 & -2 & 1 & 6 \end{array}\right]$

D. $\left[\begin{array}{ccc|c} -2 & 3 & 5 & -9 \\ 1 & 0 & -1 & -11 \\ 0 & -2 & 1 & -6 \end{array}\right]$

10. The system $-5x + y = 7$ and $-10x + 2y = 13$ has

A. a unique solution **B.** infinitely many solutions

C. exactly two solutions **D.** no solution

11. The system $x + y = 3$ and $-2x + y = 6$ has

A. no solution **B.** infinitely many solutions

C. a unique solution **D.** exactly two solutions

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

A. infinitely many solutions **B.** no solution

C. exactly one non-zero solution **D.** only the trivial solution

13. The homogeneous system $4x + 7y = 0$, $-3x - 5y = 0$ has

A. infinitely many solutions **B.** only the trivial solution

C. no solution **D.** exactly one non-zero solution

14. The system $5x - 4y - 3z = 0$, $-5x + y + 2z = 0$ and $3x - 3y - 2z = 0$ has

A. no solution **B.** infinitely many solutions

C. only the trivial solution **D.** exactly one non-trivial solution

15. For the system $-3y + 4z = 0$, $-x - y - 3z = 0$ and $3y = 0$, the determinant of the coefficient matrix is

A. 12 **B.** -10 **C.** -12 **D.** -14

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16. A system $AX = B$ in 2 unknowns has $\text{rank}(A) = 1$ and $\text{rank}[A \mid B] = 2$. The system

A. has infinitely many solutions **B.** has exactly two solutions
C. has a unique solution **D.** is inconsistent

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

A. has a unique solution **B.** has infinitely many solutions
C. is inconsistent **D.** has exactly two solutions

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

A. 18 **B.** -54 **C.** -18 **D.** 20

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19. For the system $2y + z = 8$, $2x + 4y - z = 8$ and $x + 4y + z = 14$, the determinant Δ_1 used in Cramer's rule is

A. -2 **B.** -4 **C.** -8 **D.** 4

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20. The image of $(7, -1)$ under reflection in the origin is

A. $(-7, -1)$ **B.** $(7, 1)$ **C.** $(1, -7)$ **D.** $(-7, 1)$

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21. The image of $(-4, 8)$ under reflection in the line $y = -x$ is

A. $(-8, 4)$ **B.** $(-4, -8)$ **C.** $(8, -4)$ **D.** $(4, 8)$

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22. The image of $(-2, -1)$ under reflection in the line $y = \frac{1}{2}x$ is

A. $(2, 1)$ **B.** $(-\frac{2}{5}, -\frac{11}{5})$
C. $(-2, -1)$ **D.** $(-1, -2)$

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23. The matrix of reflection in the line $y = \frac{x}{\sqrt{3}}$ is

A. $\begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix}$

B. $\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$

C. $\begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{1}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix}$

D. $\begin{bmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$

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24. When $(7, -8)$ is rotated anticlockwise about the origin through 240°, its image is

A. $(-\frac{7}{2} + 4\sqrt{3}, 4 + \frac{7\sqrt{3}}{2})$ **B.** $(\frac{7}{2} + 4\sqrt{3}, -4 + \frac{7\sqrt{3}}{2})$
C. $(4 - \frac{7\sqrt{3}}{2}, -4\sqrt{3} - \frac{7}{2})$ **D.** $(-4\sqrt{3} - \frac{7}{2}, 4 - \frac{7\sqrt{3}}{2})$

25. When $(-4, -9)$ is rotated anticlockwise about the origin through 270°, its image is

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

Key sheet

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

Solutions

1. If the matrix $\begin{bmatrix} 2 & -3 \\ -6 & k \end{bmatrix}$ has rank 1, then $k =$

Rank 1 means the matrix is singular: $2k - (-3)(-6) = 0$

$k = 9$

Ans: (A) 9

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2. For $A = \begin{bmatrix} 1 & 6 & -2 \\ 5 & -1 & 1 \\ 5 & 1 & 5 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 2 and column 3 is

Deleting row 2 and column 3 leaves $\begin{bmatrix} 1 & 6 \\ 5 & 1 \end{bmatrix}$.

$\det = (1)(1) - (6)(5) = -29$

Ans: (A) -29

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3. Is the matrix $\begin{bmatrix} 0 & 1 & 4 \\ 5 & 1 & -3 \\ 0 & 0 & 1 \end{bmatrix}$ in echelon form?

Zeros before the first non-zero entry, row by row: 1, 0, 2.

Echelon form needs this count to increase down the rows, with zero rows at the bottom. No: a row begins with fewer zeros than the row above it.

Ans: (D) No: a row begins with fewer zeros than the row above it

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4. Is the matrix $\begin{bmatrix} -2 & -3 & -3 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 6 & -2 \end{bmatrix}$ in echelon form?

Zeros before the first non-zero entry, row by row: 0, 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: (C) No: a zero row lies above a non-zero row

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5. To reduce $A = \begin{bmatrix} -3 & 0 & 4 \\ 1 & 0 & 1 \\ 2 & -2 & -1 \end{bmatrix}$ 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.

$R_3 \to R_3 \cdot R_2$ is none of these, so it can change the rank.

Ans: (A) $R_3 \to R_3 \cdot R_2$

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6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 4 & 3 \\ -2 & -8 & -6 \end{bmatrix}$ is found to be

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

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

Ans: (C) 1

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7. If $\text{rank}(A) = 2$, $\text{rank}(B) = 5$ and AB is defined, the greatest possible value of $\text{rank}(AB)$ is

$\text{rank}(AB)$ cannot exceed the rank of either A or B.

$\text{rank}(AB) \leq \min(2, 5) = 2$

Ans: (B) 2

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8. If A is a square matrix of order 7 with $\det A = 4$, then $\text{rank}(A) =$

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

A non-singular matrix of order n has rank n: here 7.

Ans: (A) 7

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9. The augmented matrix of the system $-2x + 3y + 5z = 9$, $x - z = 11$ and $-2y + z = 6$ is

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

$$[A \mid B] = \left[\begin{array}{ccc|c} -2 & 3 & 5 & 9 \\ 1 & 0 & -1 & 11 \\ 0 & -2 & 1 & 6 \end{array}\right]$$

Ans: (B) $\left[\begin{array}{ccc|c} -2 & 3 & 5 & 9 \\ 1 & 0 & -1 & 11 \\ 0 & -2 & 1 & 6 \end{array}\right]$

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10. The system $-5x + y = 7$ and $-10x + 2y = 13$ has

$\frac{a_1}{a_2} = \frac{-5}{-10}$, $\frac{b_1}{b_2} = \frac{1}{2}$, $\frac{c_1}{c_2} = \frac{7}{13}$

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

Ans: (D) no solution

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11. The system $x + y = 3$ and $-2x + y = 6$ has

$\frac{a_1}{a_2} = \frac{1}{-2}$, $\frac{b_1}{b_2} = \frac{1}{1}$, $\frac{c_1}{c_2} = \frac{3}{6}$

$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$: the lines meet in one point.

Ans: (C) a unique solution

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

$|A| = 48$

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

Ans: (D) only the trivial solution

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13. The homogeneous system $4x + 7y = 0$, $-3x - 5y = 0$ has

$|A| = 1$

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

Ans: (B) only the trivial solution

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14. The system $5x - 4y - 3z = 0$, $-5x + y + 2z = 0$ and $3x - 3y - 2z = 0$ has

$|A| = 5(-2 + 6) + 4(10 - 6) - 3(15 - 3) = 0$

$|A| = 0$, so there are infinitely many solutions, including non-trivial ones.

Ans: (B) infinitely many solutions

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15. For the system $-3y + 4z = 0$, $-x - y - 3z = 0$ and $3y = 0$, the determinant of the coefficient matrix is

$|A| = 0(0 + 9) + 3(0 - 0) + 4(-3 - 0) = -12$

Ans: (C) -12

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16. A system $AX = B$ in 2 unknowns has $\text{rank}(A) = 1$ and $\text{rank}[A \mid B] = 2$. The system

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

Ans: (D) is inconsistent

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

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

Ans: (B) has infinitely many solutions

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

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} 1 & -2 & -3 \\ -1 & -4 & -3 \\ 2 & 2 & -3 \end{vmatrix}$

$= (12 + 6) + 2(3 + 6) - 3(-2 + 8) = 18$

Ans: (A) 18

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19. For the system $2y + z = 8$, $2x + 4y - z = 8$ and $x + 4y + z = 14$, the determinant Δ_1 used in Cramer's rule is

Replace column 1 of A by the constants: $\Delta_1 = \begin{vmatrix} 8 & 2 & 1 \\ 8 & 4 & -1 \\ 14 & 4 & 1 \end{vmatrix}$

$= 8(4 + 4) - 2(8 + 14) + (32 - 56) = -4$

Ans: (B) -4

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20. The image of $(7, -1)$ under reflection in the origin is

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

Ans: (D) $(-7, 1)$

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21. The image of $(-4, 8)$ under reflection in the line $y = -x$ is

$\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} -4 \\ 8 \end{bmatrix} = \begin{bmatrix} -8 \\ 4 \end{bmatrix}$

Ans: (A) $(-8, 4)$

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22. The image of $(-2, -1)$ under reflection in the line $y = \frac{1}{2}x$ is

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

Image $(-2, -1)$

Ans: (C) $(-2, -1)$

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23. The matrix of reflection in the line $y = \frac{x}{\sqrt{3}}$ is

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

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

Ans: (A) $\begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix}$

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24. When $(7, -8)$ is rotated anticlockwise about the origin through $240°$, its image is

$$\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} 7 \\ -8 \end{bmatrix} = \begin{bmatrix} -4\sqrt{3} - \frac{7}{2} \\ 4 - \frac{7\sqrt{3}}{2} \end{bmatrix}$$

Ans: (D) $(-4\sqrt{3} - \frac{7}{2}, 4 - \frac{7\sqrt{3}}{2})$

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25. When $(-4, -9)$ is rotated anticlockwise about the origin through $270°$, its image is

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

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