EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 06

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. For $A = \begin{bmatrix} -1 & 0 & 3 \\ -4 & -1 & 5 \\ 3 & -4 & -3 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 1 and column 3 is

A. 13 **B.** 4 **C.** -19 **D.** 19

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

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

3. Is the matrix $\begin{bmatrix} 5 & 3 & -3 & -3 \\ 0 & 0 & 2 & 5 \\ 0 & 0 & 0 & -3 \end{bmatrix}$ in echelon form?

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

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

C. Yes, and its rank is 2

D. Yes, and its rank is 3

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

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

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

A. $R_2 \to R_2 - 2R_1$ **B.** $R_1 \leftrightarrow R_2$

C. $R_1 \to R_1^2$ **D.** $C_1 \leftrightarrow C_2$

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

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

7. A matrix A of order 3×2 has rank 1. Then $\text{rank}(A^T) =$

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

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8. The rank of the 6×3 null matrix is

A. 0 **B.** 3 **C.** 1 **D.** 18

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9. The augmented matrix of the system $5y + z = 9$, $-2x - 2y - 2z = -1$ and $3y - 2z = 1$ is

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

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

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

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

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10. The system $x + 4y = 8$, $-2x + ky = -6$ has no solution when $k =$

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

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11. The solution of $4x + 4y = 44$ and $-2x + 6y = 26$ is

A. $x = 5,\ y = 6$ **B.** $x = 6,\ y = 5$ **C.** $x = -5,\ y = 6$ **D.** $x = 5,\ y = -6$

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12. The homogeneous system $7x + y = 0$, $4x + 6y = 0$ has

A. only the trivial solution **B.** no solution

C. infinitely many solutions **D.** exactly one non-zero solution

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13. The system $3x + 8y = 0$, $6x + ky = 0$ has non-trivial solutions when $k =$

A. 8 **B.** 16 **C.** 4 **D.** -16

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14. For the system $-2x - z = 0$, $x + 4y + 2z = 0$ and $3x - 2y - 3z = 0$, the determinant of the coefficient matrix is

A. 28 **B.** 32 **C.** 30 **D.** -30

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

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

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

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

A. has exactly two solutions **B.** has a unique solution

C. is inconsistent **D.** has infinitely many solutions

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17. A system $AX = B$ in 3 unknowns has $\text{rank}(A) = 1$ and $\text{rank}[A \mid B] = 1$. The system

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

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18. For the system $2x + y - 3z = 3$, $x - 3y - z = -13$ and $x - 2y + z = -11$, the determinant Δ_2 used in Cramer's rule is

A. -60 **B.** 15 **C.** 60 **D.** 30

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19. For the system $x + y + z = 1$, $-3x + 4z = 15$ and $-x - y = 2$, the determinant Δ_2 used in Cramer's rule is

A. -1 **B.** 3 **C.** 9 **D.** -3

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20. The image of $(5, 6)$ under reflection in the line $y = -x$ is

A. $(-6, -5)$ **B.** $(6, 5)$ **C.** $(5, -6)$ **D.** $(-5, 6)$

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21. The image of $(-6, -2)$ under reflection in the y-axis is

A. $(6, -2)$ **B.** $(6, 2)$ **C.** $(-2, -6)$ **D.** $(-6, 2)$

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22. For reflection in the line $y = \frac{1}{4}x$, the entry $\cos 2\theta$ of the reflection matrix is

A. $\frac{8}{17}$ **B.** $-\frac{8}{17}$ **C.** $\frac{15}{17}$ **D.** $-\frac{15}{17}$

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

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

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24. The matrix that rotates every point anticlockwise about the origin through 30° is

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

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

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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25. When $(8, -9)$ is rotated anticlockwise about the origin through 45°, its image is

A. $(-\frac{17\sqrt{2}}{2}, \frac{\sqrt{2}}{2})$ **B.** $(-\frac{\sqrt{2}}{2}, \frac{17\sqrt{2}}{2})$
C. $(\frac{17\sqrt{2}}{2}, -\frac{\sqrt{2}}{2})$ **D.** $(-\frac{\sqrt{2}}{2}, -\frac{17\sqrt{2}}{2})$

Key sheet

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

Solutions

1. For $A = \begin{bmatrix} -1 & 0 & 3 \\ -4 & -1 & 5 \\ 3 & -4 & -3 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 1 and column 3 is

Deleting row 1 and column 3 leaves $\begin{bmatrix} -4 & -1 \\ 3 & -4 \end{bmatrix}$.

$\det = (-4)(-4) - (-1)(3) = 19$

Ans: (D) 19

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

$|A| = 0$

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

Ans: (C) 1

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3. Is the matrix $\begin{bmatrix} 5 & 3 & -3 & -3 \\ 0 & 0 & 2 & 5 \\ 0 & 0 & 0 & -3 \end{bmatrix}$ in echelon form?

Zeros before the first non-zero entry, row by row: 0, 2, 3.

Echelon form needs this count to increase down the rows, with zero rows at the bottom. Yes, and its rank is 3.

Ans: (D) Yes, and its rank is 3

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4. The rank of the echelon matrix $\begin{bmatrix} 0 & 1 & 6 & 4 \\ 0 & 0 & 0 & 6 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ 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. To reduce $A = \begin{bmatrix} -3 & 2 & 0 \\ -4 & 6 & 4 \\ -3 & -2 & 3 \end{bmatrix}$ 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: (C) $R_1 \to R_1^2$

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

Apply $R_2 \to R_2 + R_1$, $R_3 \to R_3 - 2R_1$: $A \sim \begin{bmatrix} 1 & -3 & -1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

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

Ans: (C) 1

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7. A matrix A of order 3×2 has rank 1. Then $\text{rank}(A^T) =$

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

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

Ans: (D) 1

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8. The rank of the 6×3 null matrix is

The rank of a null matrix is defined to be 0.

Ans: (A) 0

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9. The augmented matrix of the system $5y + z = 9$, $-2x - 2y - 2z = -1$ and $3y - 2z = 1$ is

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

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

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

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10. The system $x + 4y = 8$, $-2x + ky = -6$ has no solution when $k =$

$\frac{1}{-2} = \frac{4}{k}$ (and the constants are not in this ratio)

$k = -8$

Ans: (B) -8

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11. The solution of $4x + 4y = 44$ and $-2x + 6y = 26$ is

Eliminate one variable and substitute back.

$x = 5,\ y = 6$

Ans: (A) $x = 5,\ y = 6$

---

12. The homogeneous system $7x + y = 0$, $4x + 6y = 0$ has

$|A| = 38$

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

Ans: (A) only the trivial solution

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13. The system $3x + 8y = 0$, $6x + ky = 0$ has non-trivial solutions when $k =$

$\frac{3}{6} = \frac{8}{k}$

$k = 16$

Ans: (B) 16

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14. For the system $-2x - z = 0$, $x + 4y + 2z = 0$ and $3x - 2y - 3z = 0$, the determinant of the coefficient matrix is

$|A| = -2(-12 + 4) + 0(-3 - 6) - (-2 - 12) = 30$

Ans: (C) 30

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

$|A| = (-2 - 0) + (-4 + 1) + 5(0 + 1) = 0$

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

Ans: (B) infinitely many solutions

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16. A system $AX = B$ in 2 unknowns has $\text{rank}(A) = 2$ 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 has a unique solution.

Ans: (B) has a unique solution

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17. A system $AX = B$ in 3 unknowns has $\text{rank}(A) = 1$ and $\text{rank}[A \mid B] = 1$. The system

Unequal ranks: inconsistent. Equal ranks $= n$: unique solution. Equal ranks $< n$: infinitely many.

Here the system has infinitely many solutions.

Ans: (D) has infinitely many solutions

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18. For the system $2x + y - 3z = 3$, $x - 3y - z = -13$ and $x - 2y + z = -11$, the determinant Δ_2 used in Cramer's rule is

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} 2 & 3 & -3 \\ 1 & -13 & -1 \\ 1 & -11 & 1 \end{vmatrix}$

$= 2(-13 - 11) - 3(1 + 1) - 3(-11 + 13) = -60$

Ans: (A) -60

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19. For the system $x + y + z = 1$, $-3x + 4z = 15$ and $-x - y = 2$, the determinant Δ_2 used in Cramer's rule is

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} 1 & 1 & 1 \\ -3 & 15 & 4 \\ -1 & 2 & 0 \end{vmatrix}$

$= (0 - 8) - (0 + 4) + (-6 + 15) = -3$

Ans: (D) -3

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20. The image of $(5, 6)$ under reflection in the line $y = -x$ is

$\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 5 \\ 6 \end{bmatrix} = \begin{bmatrix} -6 \\ -5 \end{bmatrix}$

Ans: (A) $(-6, -5)$

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21. The image of $(-6, -2)$ under reflection in the y-axis is

$$\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} -6 \\ -2 \end{bmatrix} = \begin{bmatrix} 6 \\ -2 \end{bmatrix}$$

Ans: (A) $(6, -2)$

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22. For reflection in the line $y = \frac{1}{4}x$, the entry $\cos 2\theta$ of the reflection matrix is

$\cos 2\theta = \frac{1-\tan^2\theta}{1+\tan^2\theta} = \frac{1-(\frac{1}{4})^2}{1+(\frac{1}{4})^2} = \frac{15}{17}$

Ans: (C) $\frac{15}{17}$

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

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

Ans: (D) $\frac{3}{5}$

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24. The matrix that rotates every point anticlockwise about the origin through 30° is

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$$

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

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25. When $(8, -9)$ is rotated anticlockwise about the origin through 45°, its image is

$$\begin{bmatrix} \frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \end{bmatrix} \begin{bmatrix} 8 \\ -9 \end{bmatrix} = \begin{bmatrix} \frac{17\sqrt{2}}{2} \\ -\frac{\sqrt{2}}{2} \end{bmatrix}$$

Ans: (C) $(\frac{17\sqrt{2}}{2}, -\frac{\sqrt{2}}{2})$
