

How to use this worksheet. Thirty questions, about 35 minutes. Transposing a product **reverses** the order: $(AB)^T = B^T A^T$. For any system of equations compute the determinant first — non-zero means exactly one solution, answered without solving.

Formula sheet

AB exists only if columns of A = rows of B | $(AB)^T = B^T A^T$

Symmetric: $A^T = A$ | **Skew-symmetric:** $A^T = -A$, diagonal entries all 0

$|AB| = |A||B|$ | **singular if** $|A| = 0$ | $A^{-1} = \text{adj}(A)/|A|$ | $|kA| = k^n|A|$

$AX = B$: unique solution if $|A| \neq 0$; if $|A| = 0$ it is inconsistent or has infinitely many solutions

Section A · Level 1 — Types of matrix, transpose and determinant

Ten questions. None should take more than twenty seconds.

1. A matrix with the same number of rows and columns is called:

- (1) A row matrix (2) A column matrix (3) A square matrix (4) A null matrix

2. A matrix A is symmetric if:

- (1) $A^T = -A$ (2) $A^T = A$ (3) $A^2 = A$ (4) $A = 0$

3. A matrix A is skew-symmetric if:

- (1) $A^T = A$ (2) $A^T = -A$ (3) $A^T = A^{-1}$ (4) $|A| = 1$

4. Every diagonal element of a skew-symmetric matrix is:

- (1) 1 (2) -1 (3) 0 (4) Equal to the determinant

5. For two matrices A and B, $(AB)^T$ equals:

- (1) $A^T B^T$ (2) $B^T A^T$ (3) AB (4) BA

6. A square matrix A is called singular if:

- (1) $|A| = 1$ (2) $|A| = 0$ (3) $A^T = A$ (4) A is diagonal

7. The inverse of a square matrix A is given by:

- (1) $\text{adj}(A) \times |A|$ (2) $\text{adj}(A) / |A|$ (3) $|A| / \text{adj}(A)$ (4) $A^T / |A|$

8. For square matrices A and B of the same order, $|AB|$ equals:

- (1) $|A| + |B|$ (2) $|A| - |B|$ (3) $|A| \times |B|$ (4) $|A| / |B|$

9. The determinant of an identity matrix of any order is:

- (1) 0 (2) 1 (3) n (4) Undefined

10. If two rows of a determinant are identical, its value is:

- (1) 1 (2) 0 (3) Undefined (4) Equal to the order

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Orders, determinants, adjugate and inverse

Ten questions. Check that a product exists before computing it.

11. If A is of order 2×3 and B is of order 3×4 , then AB has order:

- (1) 3×3 (2) 2×4 (3) 4×2 (4) The product does not exist

12. If A is of order 2×3 and B is of order 2×3 , then AB:

- (1) Has order 2×3 (2) Has order 3×2 (3) Has order 2×2 (4) Does not exist

13. The determinant of the matrix $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ is:

- (1) -2 (2) 2 (3) 10 (4) -10

14. The determinant of the diagonal matrix $\begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}$ is:

- (1) 5 (2) 6 (3) 0 (4) 1

15. The adjugate of $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ is:

- (1) $\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$ (2) $\begin{bmatrix} 4 & 2 \\ 3 & 1 \end{bmatrix}$ (3) $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$ (4) $\begin{bmatrix} -2 & 1 \\ 1.5 & -0.5 \end{bmatrix}$

16. If $|A| = 5$ for a 3×3 matrix A , then $|2A|$ equals:

- (1) 10 (2) 20 (3) 40 (4) 5

17. If A is invertible, then $A \times A^{-1}$ equals:

- (1) A (2) The zero matrix (3) The identity matrix (4) A^T

18. The transpose of a column matrix of order 3×1 is a matrix of order:

- (1) 3×1 (2) 1×3 (3) 3×3 (4) 1×1

19. A system $AX = B$ of three equations in three unknowns has a unique solution when:

- (1) $|A| = 0$ (2) $|A| \neq 0$ (3) $B = 0$ (4) A is skew-symmetric

20. If $|A| = 0$ and the system $AX = B$ has at least one solution, then it has:

- (1) Exactly one solution (2) Infinitely many solutions (3) No solution (4) Exactly two solutions

Working space — Questions 11 to 20 Write the formula before you substitute.

Section C · Level 3 — Properties, decomposition and row operations

Eight questions. Transpose both sides when a proof looks stuck.

21. For any square matrix A , the matrix $A + A^T$ is always:

- (1) Skew-symmetric (2) Symmetric (3) Singular (4) The identity

22. Every square matrix can be written as the sum of:

- (1) Two symmetric matrices (2) A symmetric and a skew-symmetric matrix (3) Two skew-symmetric matrices (4) Two diagonal matrices

23. Matrix multiplication is:

- (1) Always commutative (2) Associative but not generally commutative (3) Neither associative nor commutative (4) Commutative only for square matrices

24. If A is a skew-symmetric matrix of odd order, then $|A|$ equals:

- (1) 1 (2) 0 (3) -1 (4) Any real number

25. Interchanging any two rows of a determinant:

- (1) Leaves it unchanged (2) Changes its sign (3) Doubles it (4) Makes it zero

26. If every element of one row of a 3×3 determinant is multiplied by k , the determinant is:

- (1) Multiplied by k (2) Multiplied by k^3 (3) Unchanged (4) Multiplied by $3k$

27. The area of a triangle with vertices given as coordinates can be found using:

- (1) The transpose (2) A determinant of order 3 (3) The adjugate (4) The identity matrix

28. If A is symmetric, then $A^T A$ is:

- (1) Skew-symmetric (2) Symmetric (3) Singular (4) The identity

Working space — Questions 21 to 28*Write the formula before you substitute.***Section D · Previous year questions — Straight from the AAI ATC papers**

Two questions from the 2023 evening paper, recovered by optical character recognition of the scanned answer sheets and independently re-solved with a computer algebra system.

29. If A, B and C are symmetric matrices of the same order, then $ABC - CBA$ is a: **[PYQ 2023 · Evening]**

(1) Identity matrix (2) Symmetric matrix (3) Skew-symmetric matrix (4) Zero matrix

30. The system of linear equations $x + 2y + 2z = 1$, $2x + 2y + 3z = 3$, $x - y + 3z = 5$ is: **[PYQ 2023 · Evening]**

(1) Inconsistent (2) Consistent with a unique solution (3) Consistent with infinitely many solutions (4) May or may not be consistent

Working space — Questions 29 to 30*Write the formula before you substitute.***Stuck on any of these? Bring them to a live class.**

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