

Matrices and Systems of Equations: math practice, Grade 12 – download the PDF

20 problems graded by difficulty (★ easy, ★★ medium, ★★★ hard). Try first, without looking at the solutions!

1 Reading a matrix

★ ★ ★

Let $M = \begin{bmatrix} 4 & -2 & 0 \\ 7 & 1 & 9 \end{bmatrix}$. (a) Give the size of M . (b) Find m_{12} and m_{23} .

2 Adding and subtracting

★ ★ ★

Let $P = \begin{bmatrix} 3 & -1 \\ 0 & 5 \end{bmatrix}$ and $Q = \begin{bmatrix} 2 & 4 \\ -6 & 1 \end{bmatrix}$. Find $P + Q$ and $P - Q$.

3 Scalar multiples

★ ★ ★

Compute (a) $-2R$ for $R = \begin{bmatrix} 1 & -3 & 2 \\ 0 & 4 & -5 \end{bmatrix}$ and (b) $\frac{1}{2}S$ for $S = \begin{bmatrix} 6 & -4 \\ 10 & 2 \end{bmatrix}$.

4 Is the product defined?

★ ★ ★

Let A be 2×3 , B be 3×4 , C be 3×1 , and D be 1×3 . For each product, say whether it is defined and give its size: (a) AB (b) BA (c) CD (d) DC .

5 Two-by-two determinants



Compute each determinant: (a) $\begin{bmatrix} 5 & 2 \\ 3 & 4 \end{bmatrix}$ (b) $\begin{bmatrix} -3 & 6 \\ 1 & -2 \end{bmatrix}$ (c) $\begin{bmatrix} 0 & 7 \\ -1 & 4 \end{bmatrix}$. Which matrix has no inverse?

6 Check an inverse



Show that $\begin{bmatrix} 2 & -1 \\ -5 & 3 \end{bmatrix}$ is the inverse of $A = \begin{bmatrix} 3 & 1 \\ 5 & 2 \end{bmatrix}$.

7 Write a system as a matrix equation



Write $4x + 3y = 11$ and $x - 3y = -1$ in the form $AX = C$, then verify that $(2, 1)$ is a solution.

8 Multiplying in both orders



Let $A = \begin{bmatrix} 1 & 4 \\ -2 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 5 & 0 \\ 2 & -1 \end{bmatrix}$. Find AB and BA . Are they equal?

9 Store revenue



A school store has two locations. Units sold of pencils, notebooks, and folders: East 30, 12, 20; West 25, 18, 10. Prices are \$0.50, \$3.20, and \$2.40. Use a matrix product to find each location's revenue.

10 A three-by-three determinant



Find $\det N$ for $N = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & 4 \\ 2 & 0 & 5 \end{bmatrix}$.

11 Finding inverses



Find the inverse of (a) $\begin{bmatrix} 4 & 3 \\ 5 & 4 \end{bmatrix}$ and (b) $\begin{bmatrix} 2 & 6 \\ 1 & 4 \end{bmatrix}$.

12 Solve with an inverse



Solve $5x + 3y = 11$ and $2x + y = 5$ using the inverse of the coefficient matrix.

13 Gaussian elimination



Use row operations to solve $x + 2y - z = 3$, $2x + 3y + z = 11$, $3x - y + z = 10$.

14 Cramer's Rule practice



Use Cramer's Rule to solve $2x + 5y = -4$ and $4x - 3y = 18$.

15 Shear then reflection



Triangle T has vertices $(1, 1)$, $(4, 1)$, $(1, 3)$. It is first sheared by $H = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$, then reflected in the x-axis by $F = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$. (a) Find the single matrix for the combined transformation. (b) Find the image of each vertex. (c) Find the area of T and of its image.

16 Rotation and reflection: order matters



Let $R = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ (rotation of 90° counterclockwise) and $F = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$ (reflection in the x-axis). Find FR and RF , and apply each to the point $(2, 5)$. What do you notice?

17 Area with determinants



Triangle OPQ has $O(0, 0)$, $P(5, 1)$, $Q(2, 4)$. (a) Find its area with a determinant. (b) The matrix $M = \begin{bmatrix} 3 & 0 \\ 1 & 2 \end{bmatrix}$ maps P and Q to P' and Q' . Find them and the area of $OP'Q'$. (c) Explain the result using $\det M$.

18 A system with a parameter



Consider $2x + ky = 5$ and $6x + 9y = 12$. (a) For which value of k does the coefficient determinant equal zero? (b) For that k , how many solutions are there? (c) Solve the system for $k = 1$ with Cramer's Rule.

19 Trail mix prices



A shop sells almonds, raisins, and cashews by the pound at prices a , r , and c dollars. An order of 2 lb almonds, 1 lb raisins, and 3 lb cashews costs \$40; 1 lb almonds, 2 lb raisins, and 1 lb cashews costs \$22; 3 lb almonds, 1 lb raisins, and 2 lb cashews costs \$38. Find the price per pound of each item (about 0.45 kg) by Gaussian elimination.

20 True or false: $AB = 0$



True or false: if A and B are 2×2 matrices with $AB = 0$, then $A = 0$ or $B = 0$. Justify with an example or a proof.



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