

CRIME SCENE

Algebra 2
Pre-Calc



MATRIX ALGEBRA



CSI ALGEBRA 2 & PRE-CALC

Matrix Algebra

IDEAL UNIT:	Matrix Algebra	TIME RANGE:	45-60 Minutes	SUPPLIES:	Pencil & Paper
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TOPICS OF FOCUS:

- Adding & Subtracting Matrices
- Scalar Multiplication
- Multiplying Matrices
- Determinants
- Inverses
- Solving Systems

COMMON CORE ALIGNMENT:

This particular unit was mapped to the curriculum of most advanced algebra textbooks. CSI activities are ideal as a small group unit review or an enrichment activity.

N-VM.6	Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
N-VM.7	Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
N-VM.8	Add, subtract, and multiply matrices of appropriate dimensions.
N-VM.9	Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
N-VM.12	Work with 2×2 matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area.
A-REI.8	Represent a system of linear equations as a single matrix equation in a vector variable.



CSI

General Procedures

*A.) As an optional hook, you can provide or read students the letter from Chief Harris. These are relatively the same for each CSI activity and introduce the criminal, world region the crimes take place and the math topic.

B.) Provide groups (ideally 2-3), the possible suspects, 6 crime scene puzzles and worksheet. You may choose to laminate the criminals or crime scenes for easier reuse. They also work well printed as a packet.

C.) Students will work to solve the crime. Generally, it takes between 45-60 minutes to complete. You can drop hints or provide assistance to help groups that are behind the pace. There are some problems that push advanced critical thinking in applications and others that focus on repeated skill practice. Previewing which crime scenes might be the most challenging so you can be prepared to help small groups or the whole class is a good idea.

Answers in this document are provided, but not with much detail because there have been instances of students or their parents purchasing the documents when teachers have opted to use it as a summative assessment.

D.) At the end of each scene, students will receive a clue that will substitute into the “Cryptic Text Message”. This provides an element of self-checking because if the Cryptic Text does not lead to a criminal, they know they need to recheck their work. In the end, students will determine which suspect should be arrested. *The gender, race and ethnicity of the guilty “suspect” is intentionally varied across the entire CSI series.*

*E.) There is an emphasis on “evidence” since this is an investigation. This means detailed work and the ability to argue their logic. You may like for students to create a portfolio of evidence proving that they have arrested the right person and will demonstrate their understanding of their mathematical content present in the problem.

*F.) Some teachers enjoy having their students present and defend their evidence to the class in a brief oral presentation.

*Optional Extensions

THE EVIDENCE

INVESTIGATOR: _____



1.

CLUE

2.

CLUE

3.

CLUE



4.

CLUE

5.

CLUE

6.

CLUE

CRYPTIC TEXT MESSAGE

SUSPECT

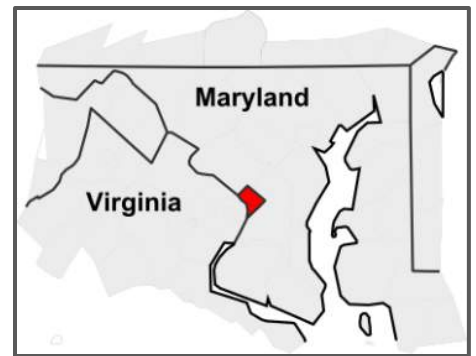
CSI: Matrix Algebra



Detectives,

Once again the world has been sent reeling by a string of high profile robberies. This time it seems Washington D.C. has been victims of the evil genius group, the Mathemagicians. Notes signed “Neo Eigenvector” have been discovered at each of the robbery sites. Once again a cryptic text message was sent to investigators, but it requires the puzzles to be cracked first. We believe the Mathemagicians have been successfully piecing together a world conquering device.

We’ve been told the result of the cryptic text message will calculate to Neo’s favorite number. Thus far there are six suspects that police have questioned. It is hoped that someone with a relatively strong number sense can crack some codes that have puzzled the detectives on the case so far.



Your job is to bring Neo to justice and save the planet. You need to be prepared to state your case and demonstrate your understanding of the following skills that Neo is known to use in his/her notes.

- Adding, Subtracting and Scalar Multiplication of Matrices
- Multiplying Matrices
- Determinants
- Inverses
- Solving Systems

In your investigation, be sure to show all of your work. We need to have clear evidence that supports your calculations and conclusions. This is not a time to be sloppy. The slightest miscalculation or illegible footnote could result in a not guilty verdict.

Oh, did I mention that use of a calculator might prematurely set off his world conquering device? Good luck to you, gumshoe.

Chief Harris



THE SUSPECTS

Who is Neo Eigenvector?



<p>NAME Cesar</p> <p>OCCUPATION Engineer</p> <p>FAVORITE NUMBER 445</p> 	<p>NAME Bella</p> <p>OCCUPATION Political Scientist</p> <p>FAVORITE NUMBER 4.0</p> 
<p>NAME Elizabeth</p> <p>OCCUPATION Hair Stylist</p> <p>FAVORITE NUMBER -10</p> 	<p>NAME Dylan</p> <p>OCCUPATION Liberal Arts Professor</p> <p>FAVORITE NUMBER 97,832</p> 
<p>NAME DeAndre</p> <p>OCCUPATION Small Business Owner</p> <p>FAVORITE NUMBER 500</p> 	<p>NAME Marcy</p> <p>OCCUPATION Artist</p> <p>FAVORITE NUMBER 56,748</p> 



Scene #1 U.S. Capitol Building -- Washington, D.C.



Security guards were surprised to learn that Neo Eigenvector apparently made copies of Top Secret government files which may expedite the building of a World Conquering Device. In the Senate restroom, police found this note written on a stall.

$A = \begin{bmatrix} 2 & 1 \\ 2 & 4 \end{bmatrix} \qquad B = \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$ $C = \begin{bmatrix} 10 & 6 & 0 \\ 2 & -3 & 5 \end{bmatrix} \qquad D = \begin{bmatrix} -8 & -3 & -2 \\ -1 & -4 & 6 \end{bmatrix}$ $E = \begin{bmatrix} 4 & 3 \\ -1 & 2 \\ 5 & -9 \end{bmatrix} \qquad F = \begin{bmatrix} 0 & -7 \\ 5 & 1 \\ 2 & -2 \end{bmatrix}$	<p>Welcome to the Matrix of Matrices. I will free your mind. But first I must frustrate my mind and journey to Congress, where I overheard this exchange...</p> <p>“I can create more complicated meandering square matrices than you!” yells the House. “Wanna bet?” the Senate replies, “My determinant will be bigger than your determinant!!”</p>
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Do these operations create possible matrices? What is the determinant?

House	$((D + 2C) \times E) - 5B$
Senate	$((A \times C) + 3D) + F$

House is Larger h = its determinant	Senate is Larger s = its determinant	Neither is Possible w = 0	_____ = _____
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Scene #2 John's Hopkins Medical Center -- Baltimore, Maryland

After a quick trip down the highway, Neo broke into one of the world's top medical schools and stole radiation materials. Investigators are unclear how they will be used in the world conquering device.



Four long-term patients require three kinds of medications. The 3x4 matrix shows the amounts of the medication each patient requires each day. If Patient A stays 10 days, Patient B stays 5 days, Patient C stays 20 days, and Patient D stays 10 days, *how much of each type of medication must the medical staff have on hand?*

	Patient A	Patient B	Patient C	Patient D
Prilosec	5 units	50 units	25 units	15 units
Hydrocodone	15 units	5 units	20 units	20 units
Prednisone	25 units	10 units	15 units	30 units

Which of the following amounts is not enough?

925 units of Prilosec	➡	a = 925
775 units of Hydrocodone	➡	c = 775
900 units of Prednisone	➡	d = 900

Scene #3 Langley Air Force Base -- Langley, Virginia



Air traffic controllers were startled to find that one of the military stealth bombers was hotwired and stolen. Later, in sidewalk chalk they found this note on the runway.

An interesting thing I have learned is that everyone around here speaks in code. I've decided to join in on the fun. I have encrypted a word that has been connected to D.C. perhaps longer than any of its kind.

Here's the Biology of Cryptology Methodology:

$AB = X$ and thus $XB^{-1} = A$ where A equals the Unencrypted Matrix, B is the encoding matrix and X is the Encrypted Matrix.



The unencrypted matrix will become a word (A = 1, B = 2, etc.)

Encrypted Matrix	Encoding Matrix	Encoding Inverse
$X = \begin{bmatrix} 102 & 216 \\ 98 & 219 \\ 64 & 167 \\ 44 & 107 \\ 80 & 140 \end{bmatrix}$	$B = \begin{bmatrix} 4 & 7 \\ 2 & 6 \end{bmatrix}$	

Is the encrypted word a...

Country ↓ A = 5	Person ↓ C = 15	Animal ↓ H = 25	City ↓ S = 30
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_____ = _____

Scene #4 Smithsonian Museum of Natural History -- Washington, D.C.



Posing as an ordinary tourist, Neo Eigenvector stole the femur of an adult Apatosaurus.



Despite popular belief, there is not a treasure map on the back of the Declaration of Independence. However after a little inspection, there is a 4x4 determinant problem doodled by Ben Franklin. Don't believe me? Go see for yourself. *Solve this monster determinant to get your next clue.*

W = the determinant

W = _____

10	7	-7	5
-9	0	2	-1
3	-3	1	-4
-1	8	5	2

Scene #5 White House -- Washington, D.C.

Although the details are sketchy, a Secret Service member identified a person posing as a gardener digging up Michelle Obama's vegetable garden. All the tomatoes were taken!



DC MONUMENT BIKE TOUR



CHILDREN \$25	ADULTS \$40	SENIORS \$30
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You can't drive around D.C. without nearly running over an 8th grader. What gives? Why do schools only bring 8th graders to D.C.? So of course I got stuck behind a group in line for a bike tour and I waited long enough to figure out a system of equations with three variables... so yeah... I waited a long time.

There are 188 people on the trip and their total cost for the bike tour was \$5040. There were twelve more adults than seniors on the trip. How many children were there?

148 → **a = 25**

154 → **d = 25**

160 → **s = 25**

Scene #6 The Pentagon -- Washington, D.C.



Last night, Neo Eigenvector repelled into the heavily alarmed wing of the Pentagon. Neo most definitely has soft feet because he made a getaway with a top secret safe. When asked about the contents of the safe, a Pentagon spokesperson said, "Yeah, it's bad."

One thing I learned on my trip: Don't touch any buttons at the Pentagon. The Mathematicians want OUR Device to conquer the world, not there's.

Thanks to someone Tweeting out some info, I got the scoop on an imminent search operation that the Army is planning.

Each unit represents 1 mile, thus each square represents 1 mi². The military has established a perimeter with three stations.

How much area do they need to cover for this operation? HINT:

$$\text{Area} = \pm \frac{1}{2} \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$$



50



a = 50

55



c = 55

60



d = 60

65



h = 65

CRYPTIC PUZZLE SOLVER TEXT MESSAGE

Exiting the Matrix...

W • A ÷ S + H - D • C

Your new BFF, Neo Eigenvector

CSI

Matrix Algebra Rubric



Skills & Understandings		Exemplary	Proficient	Developing
I can recognize when two matrices can be added or subtracted and can do it correctly.				
I can multiply a matrix by a scalar.				
I can recognize when two matrices can be multiplied and can do it correctly.				
I can calculate the determinant of a square matrix.				
I can calculate and apply the inverse of a matrix.				
I can solve a system of equations with matrix algebra.				
Math Processes		Exemplary	Proficient	Developing
Skills & Mechanics	<i>accurately performs calculations</i>			
	<i>demonstrates fluency with mathematical skills and processes</i>			
Applications	<i>accurately interprets word problems and addresses them with appropriate math skills</i>			
	<i>can articulate the meaning of calculations in the context of the problems.</i>			
Use of Evidence & Analysis	<i>can determine what evidence is appropriate to answer a question</i>			
	<i>utilizes mathematical outcomes to support their conclusions</i>			

COMMENTS: