Question	Scheme	Marks	AOs
1(a)	(i) $\mathbf{AB}=\begin{pmatrix}4&-1\\7&2\\-5&8\end{pmatrix}\begin{pmatrix}2&3&2\\-1&6&5\end{pmatrix}=\begin{pmatrix}8+1&12-6&8-5\\14-2&21+12&14+10\\-10-8&-15+48&-10+40\end{pmatrix}=\begin{pmatrix}9&6&3\\12&33&24\\-18&33&30\end{pmatrix}$	M1	1.1b
	So $\mathbf{AB}-3\mathbf{C}=\begin{pmatrix}9&6&3\\12&33&24\\-18&33&30\end{pmatrix}-\begin{pmatrix}-15&6&3\\12&9&24\\-18&33&6\end{pmatrix}=\begin{pmatrix}24&0&0\\0&24&0\\0&0&24\end{pmatrix}$ or $\mathbf{AB}-3\mathbf{C}=\begin{pmatrix}9&6&3\\12&33&24\\-18&33&30\end{pmatrix}+\begin{pmatrix}15&-6&-3\\-12&-9&-24\\18&-33&-6\end{pmatrix}=\begin{pmatrix}24&0&0\\0&24&0\\0&0&24\end{pmatrix}$ and states a value for k	M1	1.1b
	Hence $\mathbf{AB}-3\mathbf{C}-24\mathbf{I}=\mathbf{0}$ so $k=-24$	A1	1.1b
	(ii) Need two things One of: • **BA** is a 2×2 matrix • Finds the matrix **BA** (must be a 2×2 matrix) AND One of: • cannot subtract a 3×3 matrix • finds matrix **3C** and comments that they have different dimensions / can't be done • can't subtract matrices of different sizes • 3**C** or **C** is a 3×3 matrix • **BA** needs to be a 3×3 matrix	B1	2.4
		(4)	
(b)(i)	$\begin{pmatrix}-5&2&1\\4&3&8\\-6&11&2\end{pmatrix}\begin{pmatrix}x\\y\\z\end{pmatrix}=\begin{pmatrix}-14\\3\\7\end{pmatrix}\Rightarrow\begin{pmatrix}x\\y\\z\end{pmatrix}=\begin{pmatrix}-5&2&1\\4&3&8\\-6&11&2\end{pmatrix}^{-1}\begin{pmatrix}-14\\3\\7\end{pmatrix}$ Or states $\begin{pmatrix}x\\y\\z\end{pmatrix}=\mathbf{C}^{-1}\begin{pmatrix}-14\\3\\7\end{pmatrix}$ Or states $\begin{pmatrix}x\\y\\z\end{pmatrix}=\frac{1}{360}\begin{pmatrix}-82&7&13\\-56&-4&44\\62&43&-23\end{pmatrix}\begin{pmatrix}-14\\3\\7\end{pmatrix}$	M1	1.2
(ii)	$=\frac{1}{360}\begin{pmatrix}-82&7&13\\-56&-4&44\\62&43&-23\end{pmatrix}\begin{pmatrix}-14\\3\\7\end{pmatrix}=\ldots$	M1	1.1b

	$= \begin{pmatrix} -\frac{41}{180} & \frac{7}{360} & \frac{13}{360} \\ -\frac{7}{45} & -\frac{1}{90} & \frac{11}{90} \\ \frac{31}{180} & \frac{43}{360} & -\frac{23}{360} \end{pmatrix} \begin{pmatrix} -14 \\ 3 \\ 7 \end{pmatrix} = \ldots$ $\mathbf{C}^{-1} \begin{pmatrix} -14 \\ 3 \\ 7 \end{pmatrix} = \ldots$		
	So solution is $x = \frac{7}{2}, y = 3, z = -\frac{5}{2}$ or $(3.5,\ 3,\ -2.5)$	A1	1.1b
		(3)	
			(7 marks)

Notes:

(a) (i)

M1: Attempts to find **AB**. Usually this will be done on calculator so answer implies the method. If answer is incorrect allow for at least 6 correct entries or calculations shown.

This mark can be implied by a correct matrix for $\mathbf{AB} - 3\mathbf{C}$ gives the first M1

M1: Uses their **AB** and **3C** matrices to find a multiple **I** and states a value for k

A1: Correct proof with $k = -24$ seen explicitly (may be in equation).

Minimum working required is $\mathbf{AB} - 3\mathbf{C} = \begin{pmatrix} 24 & 0 & 0 \\ 0 & 24 & 0 \\ 0 & 0 & 24 \end{pmatrix}$ gets M1 then states a value for k M1

then $k = -24$ gets A1

Special case: If minimum working required is not seen and just $k = -24$ stated then M1 M0 A0 as they have not shown that the value of k works.

(ii)

B1: Correct explanation referring to the dimensions of **BA** and **C** (or 3**C**) and that they do not match in the equation. They can find both these matrices and then comment they cannot be subtracted.

(b) Mark (i) and (ii) altogether

M1: States or implies use of the correct method of using the inverse matrix.

M1: Carries out the process of multiplying after finding the inverse. May find inverse long hand first. Finding the inverse matrix then writes down an answer gains M1.

Note: There is no need to find the inverse matrix. If the inverse matrix is not stated just answers written down then two out of the three correct ordinates imply the M1.

A1: Correct solution. Must be clear that $x = \frac{7}{2}, y = 3, z = -\frac{5}{2}$ allow $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 3.5 \\ 3 \\ -2.5 \end{pmatrix}$

Note: If they solve using simultaneous equations only this is M0 M0 A0

If there is no reference to the inverse matrix and correct answers stated this is M0 M0 A0