(a) evidence of addition (M1)
e.g. at least two correct elements

$\boldsymbol{A}+\boldsymbol{B}=\begin{pmatrix}4 & 2\\1 & 0\end{pmatrix}$ A1 N2

(b) evidence of multiplication (M1)
e.g. at least two correct elements

$-3\boldsymbol{A}=\begin{pmatrix}-3 & -6\\-9 & 3\end{pmatrix}$ A1 N2

(c) evidence of matrix multiplication (in correct order) (M1)

e.g. $\boldsymbol{AB}=\begin{pmatrix}1(3)+2(-2) & 1(0)+2(1)\\3(3)+(-1)(-2) & 3(0)+(-1)(1)\end{pmatrix}$

$\boldsymbol{AB}=\begin{pmatrix}-1 & 2\\11 & -1\end{pmatrix}$ A2 N3

[7]

(a) $\det\boldsymbol{A}=2$ (A1)

$\boldsymbol{A}^{-1}=\frac{1}{2}\begin{pmatrix}3 & 4\\1 & 2\end{pmatrix}\left(=\begin{pmatrix}\frac{3}{2} & 2\\\frac{1}{2} & 1\end{pmatrix}\right)$ A1 N2 2

(b) evidence of multiplying by $\boldsymbol{A}^{-1}$ (M1)

e.g. $\boldsymbol{X}=\boldsymbol{A}^{-1}\begin{pmatrix}4 & 6\\2 & -2\end{pmatrix}$, $\boldsymbol{A}^{-1}\boldsymbol{B}$

correct working A1

e.g. $\boldsymbol{X}=\frac{1}{2}\begin{pmatrix}3 & 4\\1 & 2\end{pmatrix}\begin{pmatrix}4 & 6\\2 & -2\end{pmatrix}, \begin{pmatrix}\frac{3}{2} & 2\\\frac{1}{2} & 1\end{pmatrix}\begin{pmatrix}4 & 6\\2 & -2\end{pmatrix}, \frac{1}{2}\begin{pmatrix}20 & 10\\8 & 2\end{pmatrix}$

$\boldsymbol{X}=\begin{pmatrix}10 & 5\\4 & 1\end{pmatrix}$ A2 N3 4

[6]

(a) evidence of considering determinant (M1)

e.g. $3 \times -3 - (-2) \times x$, attempt to find inverse

setting the determinant equal to zero (M1)

e.g. $-9 + 2x = 0$, $2x = 9$

$x = \frac{9}{2}$ A1 N2 3

(b) **METHOD 1**

$A^{-1} = \frac{1}{-9+2x}\begin{pmatrix} -3 & -x \\ 2 & 3 \end{pmatrix}$ (A1) (A1)

Note: *Award A1 for* $\frac{1}{\det \boldsymbol{A}}$, *A1 for* $\begin{pmatrix} -3 & -x \\ 2 & 3 \end{pmatrix}$.

one correct equation from $\boldsymbol{A} = \boldsymbol{A}^{-1}$ (A1)

e.g. $\frac{-3}{-9+2x} = 3$, $\frac{2}{-9+2x} = 2$, $\frac{3}{-9+2x} = -3$, $\frac{-x}{-9+2x} = x$

attempt to solve the equation (M1)

e.g. $-3 = 3(-9 + 2x)$, $-9 + 2x = -1$

$x = 4$ (do **not** accept $x = 4$, $x = 0$) A1 N4 5

METHOD 2

$\boldsymbol{A}^2 = \boldsymbol{I}$ (A1)

$\boldsymbol{A}^2 = \begin{pmatrix} 9-2x & 0 \\ 0 & -2x+9 \end{pmatrix}$ (A1)

one correct equation from $\boldsymbol{A}^2 = \boldsymbol{I}$ (A1)

e.g. $9 - 2x = 1$

attempt to solve the equation (M1)

e.g. $2x = 8$

$x = 4$ A1 N4 5

[8]

(a) evidence of multiplying — (M1)

e.g. one correct element

$\boldsymbol{AB} = \begin{pmatrix} -15 \\ 5 \end{pmatrix}$ — A1A1 — N3

(b) **METHOD 1**

evidence of multiplying by $\boldsymbol{A}$ (on left or right) — (M1)

e.g. $\boldsymbol{AA}^{-1}\boldsymbol{X} = \boldsymbol{AB}$, $\boldsymbol{X} = \boldsymbol{AB}$

$\boldsymbol{X} = \begin{pmatrix} -15 \\ 5 \end{pmatrix}$ (accept $x = -15$, $y = 5$) — A1 — N2

METHOD 2

attempt to set up a system of equations — (M1)

e.g. $\frac{4x+2y}{10} = -5$, $\frac{-3x+y}{10} = 5$

$\boldsymbol{X} = \begin{pmatrix} -15 \\ 5 \end{pmatrix}$ (accept $x = -15$, $y = 5$) — A1 — N2

[5]

(a) (i) $\boldsymbol{AB} = \begin{pmatrix} 4 & 0 \\ 0 & 4 \end{pmatrix}$ $(= 4\boldsymbol{I})$ — A2 — N2

(ii) $\boldsymbol{A}^{-1} = \frac{1}{4}\begin{pmatrix} 2 & -1 \\ -6 & 5 \end{pmatrix}, \frac{1}{4}\boldsymbol{B}, \begin{pmatrix} \frac{1}{2} & -\frac{1}{4} \\ -\frac{3}{2} & \frac{5}{4} \end{pmatrix}$ — A1 — N1

(b) **METHOD 1**

$\begin{pmatrix} x \\ y \end{pmatrix} = \boldsymbol{A}^{-1}\boldsymbol{C}$ — (M1)

$= \frac{1}{4}\begin{pmatrix} 2 & -1 \\ -6 & 5 \end{pmatrix}\begin{pmatrix} 8 \\ -4 \end{pmatrix} \left(\begin{pmatrix} \frac{1}{2} & -\frac{1}{4} \\ -\frac{3}{2} & \frac{5}{4} \end{pmatrix}\begin{pmatrix} 8 \\ -4 \end{pmatrix} \right)$ — A1

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ -17 \end{pmatrix}$ — A1A1 — N3

METHOD 2

$5x + y = 8$, $6x + 2y = -4$ — A1

for work towards solving **their** system — (M1)

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ -17 \end{pmatrix}$ — A1A1 — N3

[7]

(a) **METHOD 1**

$\boldsymbol{M} = (\boldsymbol{M}^{-1})^{-1}$ (M1)

$\boldsymbol{M} = \frac{1}{10}\begin{pmatrix} 2 & 0 \\ -1 & 5 \end{pmatrix}$ A1A1 N3

METHOD 2

$\begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} 5 & 0 \\ 1 & 2 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ (M1)

$5a + b = 1$, $2b = 0$, $5c + d = 0$, $2d = 1$ (A1)

$\boldsymbol{M} = \begin{pmatrix} 0.2 & 0 \\ -0.1 & 0.5 \end{pmatrix}$ A1 N3

(b) **METHOD 1**

evidence of appropriate approach (M1)
e.g. $\boldsymbol{X} = \boldsymbol{M}^{-1}\boldsymbol{B}$

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 & 0 \\ 1 & 2 \end{pmatrix}\begin{pmatrix} 1 \\ 7 \end{pmatrix}$ A1

$= \begin{pmatrix} 5 \\ 15 \end{pmatrix}$ A1 N2

METHOD 2

evidence of appropriate approach (M1)
e.g. $\begin{pmatrix} 0.2 & 0 \\ -0.1 & 0.5 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 1 \\ 7 \end{pmatrix}$

$0.2x = 1$, $-0.1x + 0.5y = 7$ A1

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ 15 \end{pmatrix}$ A1 N2

[6]

(a) evidence of correct method (M1)

e.g. at least 1 correct element (must be in a 2 × 2 matrix)

$\boldsymbol{AB} = \begin{pmatrix} -2-2q & 0 \\ -6+pq & 3+\frac{p}{2} \end{pmatrix}$ A1 N2

(b) **METHOD 1**

evidence of using $\boldsymbol{AB} = \boldsymbol{I}$ (M1)

2 correct equations A1A1

e.g. $-2-2q = 1$ and $3 + \frac{p}{2} = 1$, $-6 + pq = 0$

$p = -4$, $q = -\frac{3}{2}$ A1A1 N1N1

METHOD 2

finding $\boldsymbol{A}^{-1} = \frac{1}{p+6}\begin{pmatrix} p & 2 \\ -3 & 1 \end{pmatrix}$ A1

evidence of using $\boldsymbol{A}^{-1} = \boldsymbol{B}$ (M2)

e.g. $\frac{2}{p+6} = 1$ and $-\frac{3}{p+6} = q$, $\frac{p}{p+6} = -2$ and $-\frac{3}{p+6} = q$

$p = -4$, $q = -\frac{3}{2}$ A1A1 N1N1

[7]

(a) Attempt to multiply *e.g.* $\begin{pmatrix} 1+0 & -2-6 \\ 0+0 & 0+9 \end{pmatrix}$ (M1)

$\boldsymbol{A}^2 = \begin{pmatrix} 1 & -8 \\ 0 & 9 \end{pmatrix}$ A1 N2

(b) $3\boldsymbol{X} + \begin{pmatrix} 1 & -2 \\ 0 & 3 \end{pmatrix} = \begin{pmatrix} -3 & 4 \\ 2 & 1 \end{pmatrix}$ (M1)

$3\boldsymbol{X} = \begin{pmatrix} -4 & 6 \\ 2 & -2 \end{pmatrix}$ (A1)

$\boldsymbol{X} = \frac{1}{3}\begin{pmatrix} -4 & 6 \\ 2 & -2 \end{pmatrix}$ A1 N2

[5]