Question	Scheme	Marks	AOs
8 (a)	$x + y + z = 1400$ $x - y = 360$ o.e.	M1 A1	3.3 1.1b
		(2)	
(b)	$0.08x + 0.05y - 0.1z = 70$ o.e $1.08x + 1.05y + 0.9z = 1470$ o.e	B1	1.1b
		(1)	
(c)	$\begin{pmatrix} 1 & 1 & 1 \\ 1 & -1 & 0 \\ 1.08 & 1.05 & 0.9 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1400 \\ 360 \\ 1470 \end{pmatrix}$ or $\begin{pmatrix} 1 & 1 & 1 \\ 1 & -1 & 0 \\ 0.08 & 0.05 & -0.1 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1400 \\ 360 \\ 70 \end{pmatrix}$	M1 A1ft	3.1b 1.1b
	$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 \\ 1 & -1 & 0 \\ 1.08 & 1.05 & 0.9 \end{pmatrix}^{-1}\begin{pmatrix} 1400 \\ 360 \\ 1470 \end{pmatrix} = \begin{pmatrix} \cdots \\ \cdots \\ \cdots \end{pmatrix}$ or $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 \\ 1 & -1 & 0 \\ 0.08 & 0.05 & -0.1 \end{pmatrix}^{-1}\begin{pmatrix} 1400 \\ 360 \\ 70 \end{pmatrix} = \begin{pmatrix} \cdots \\ \cdots \\ \cdots \end{pmatrix}$	dM1	3.4
	At the start of the study there were **800** carp, **440** tench and **160** pike	A1	3.2a
		(4)	
			(7 marks)

Notes

(a)

M1: Attempts to use the model to set up at least 2 equations

A1: 2 correct simplified equations (decimals or fractions), one for each different piece of information.

Ignore any additional equations even if incorrect.

(b)

B1: correct simplified equation (decimals or fractions)

Ignore any additional equations even if incorrect.

(c)

M1: Uses their equation in part(a) to **s**et up a matrix equation of the form $\begin{pmatrix} \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots \end{pmatrix}\begin{pmatrix} \boldsymbol{x} \\ \boldsymbol{y} \\ \boldsymbol{z} \end{pmatrix} = \begin{pmatrix} \cdots \\ \cdots \\ \cdots \end{pmatrix}$, where "…" are numerical values.

A1ft: Correct matrix equation for their equations

dM1: Dependent on previous method mark.

Writes $\left((their\boldsymbol{A}^{-1}) \begin{pmatrix} 1400 \\ \text{their "360"} \\ \text{their "1470"} \end{pmatrix} \right)$ and obtains at least one value of *x*, *y* or *z*.

The inverse matrix need not be found, writing $\boldsymbol{A}^{-1} \begin{pmatrix} 1400 \\ \text{"360"} \\ \text{"1470"} \end{pmatrix} = \ldots$ is sufficient.

A correct matrix equation followed by correct values implies this mark.

Condone $\begin{pmatrix} 1400 \\ \text{"360"} \\ \text{"1470"} \end{pmatrix} \boldsymbol{A}^{-1} = \ldots$ as long as they reach some values. The values imply the correct method

Note: Inverse matrices will be equivalent to $\frac{1}{33}\begin{pmatrix} -90 & 15 & 100 \\ -90 & -18 & 100 \\ 213 & 3 & -200 \end{pmatrix}$ or $\frac{1}{33}\begin{pmatrix} 10 & 15 & 100 \\ 10 & -18 & 100 \\ 13 & 3 & -200 \end{pmatrix}$

A1: Interprets the answer in the context of the question, minimum is $x = 800$, $y = 440$, $z = 160$ with their variables.

Note: they must be using a matrix equation to solve the equation to score any marks.