i). $S = \mathbb{M}(2, \mathbb{R})$ $a = \begin{pmatrix} r_1 & r_2 \\ r_3 & r_4 \end{pmatrix}$ $b = \begin{pmatrix} r_5 & r_6 \\ r_7 & r_8 \end{pmatrix}$

$$a * b = \begin{pmatrix} r_1 + r_5 & r_2 + r_6 \\ r_3 + r_7 & r_4 + r_8 \end{pmatrix}$$

- $a * b \in S$ $(\forall)$ $a, b \in S$ it is a binary operation

- commutative:

$$a * b = \begin{pmatrix} r_1 + r_5 & r_2 + r_6 \\ r_3 + r_7 & r_4 + r_8 \end{pmatrix} = b * a \quad (\forall)\, a, b \in S$$

- associative: let $c = \begin{pmatrix} r_9 & r_{10} \\ r_{11} & r_{12} \end{pmatrix} \in \mathbb{M}(2, \mathbb{R})$

$$(a * b) * c = \begin{pmatrix} (r_1 + r_5) + r_9 & (r_2 + r_6) + r_{10} \\ (r_3 + r_7) + r_{11} & (r_4 + r_8) + r_{12} \end{pmatrix} =$$

$$= \begin{pmatrix} r_1 + (r_5 + r_9) & r_2 + (r_6 + r_{10}) \\ r_3 + (r_7 + r_{11}) & r_4 + (r_8 + r_{12}) \end{pmatrix} = a * (b * c)$$

j). $S = \mathcal{P}(X)$ $A * B = (A \Delta B) \Delta B$ where $X \neq \emptyset$

we know that Δ is a binary operation, so
$A * B \in \mathcal{P}(X)$ $(\forall)$ $A, B \in \mathcal{P}(X)$

we also know that Δ is associative:

$$A * B = (A \Delta B) \Delta B = A \Delta (B \Delta B) = A$$