NB: Please deposit your solutions in the appropriate box **by 4 p.m. on the due date**. Late assignments or assignments placed into incorrect boxes will not be marked. Use a mathematics department cover sheet: these are available from outside the Resource Centre.

PLEASE SHOW ALL WORKING.

1. (**10 marks**) Let $\mathbb{R}^*$ be the set of non-zero real numbers.

(a) Show the ordinary division / is a binary operation of $\mathbb{R}^*$

(b) Show $(\mathbb{R}^*, /)$ has no identity.

(c) Show / is not associative.

2. (**10 marks**) Let $\mathbb{R}^+$ be the set of positive real numbers. Show $\mathbb{R}^+$ is a group under ordinary multiplication.

3. (**18 marks**) Let X be a non-square rectangle and $S(X)$ the set of all symmetries of X.

(a) Describe each symmetry in $S(X)$.

(b) Construct the Cayley table of $S(X)$ under composition.

(c) Find the identity and for each element find its inverse.

4. (**12 marks**) Let $D_3 = \{R_0, R_{120}, R_{240}, V, V', V''\}$ be the set of all symmetries of an equilateral triangle (given in class).

(a) Write out the Cayley table of D_3 under composition $*$.

(b) Show that there are some $x, y \in D_3$ such that $x * y \neq y * x$.