

### Life in Quadania

In the far off planet Quadania, alien creatures are born with two fingers on each hand. Therefore, young quadanians grow up using *quadal*, a base four notation formed by the digits 0, 1, 2, and 3. This problem deals with exchanging numerical data with this advanced but unusual lifeform.

**Part A** Convert the following numbers between quadal and our more familiar notations.

$$21.302_4 = \underline{\hspace{15em}}_2$$

$$31210_4 = \underline{\hspace{15em}}_{16}$$

$$123.21_4 = \underline{\hspace{15em}}_8$$

$$DA91_{16} = \underline{\hspace{15em}}_4$$

$$15.25_8 = \underline{\hspace{15em}}_4$$

$$197_{10} = \underline{\hspace{15em}}_4$$

$$32.21_4 = \underline{\hspace{15em}}_{10}$$

$$4^{13} = \underline{\hspace{15em}}_{10}$$

**Part B** For each problem, (a) compute the operation using the rules of addition, expressing your answer in quadal notation, (b) indicate whether an error occurs assuming all numbers are expressed using a **six** bit, two's complement representation, and (c) indicate whether an error occurs assuming all numbers are expressed using a **six** bit, unsigned binary representation. All number are expressed in quadal notation.

$$\begin{array}{r} 3\ 1 \\ +\ 2\ 3 \\ \hline \end{array} \qquad \begin{array}{r} 1\ 2\ 3 \\ +\ 3\ 2\ 1 \\ \hline \end{array} \qquad \begin{array}{r} 2\ 2\ 1 \\ +\ 2\ 3\ 2 \\ \hline \end{array} \qquad \begin{array}{r} 1\ 2\ 3 \\ +\ 1\ 2\ 3 \\ \hline \end{array}$$

signed error?  signed error?  signed error?  signed error?

unsigned error?  unsigned error?  unsigned error?  unsigned error?

**Part C** The favorite soft drink in Quadania is Quadacola (jingle: "Always Quadacola!"). A Quadacola costs 16 cents using two coins: Quads (4 cents) and Octs (8 cents). Draw a state diagram with four states which represents the operation of a Quadacola machine. Inputs are active high "Quad" (*Q*) and "Oct" (*O*) signals. Quad and Oct signals cannot be high simultaneously. There is no "bad coin" input; quadanians are very honest. The active high outputs are "Reject" (*R*) and "Give Quadacola" (*GQ*). Complete the state diagram below by adding all required transition arcs with input and output annotations.

