One Pair

$$C\binom{52}{5} = 2,598,960$$

$$C\binom{4}{2} \cdot 13 \cdot C\binom{12}{3} \cdot 4 \cdot 4 \cdot 4$$

$$= 6 \cdot 13 \cdot 220 \cdot 64 = 1,098,240$$

$$\frac{1,098\,240}{2,598,960} = .4226$$

Simulated rate = .417

Two pair

$$C\binom{13}{2} \cdot C\binom{4}{2} \cdot C\binom{4}{2} \cdot 44$$

$$= 78 \cdot 6 \cdot 6 \cdot 44$$

$$= 123,552$$

$$\frac{123,552}{2,598,960} = .0475$$

Simulated = .04

Three of a kind

$$13 \cdot C\binom{4}{3} \cdot C\binom{12}{2} \cdot 4 \cdot 4$$

$$= 13 \cdot 4 \cdot 66 \cdot 4 \cdot 4$$

$$= 54,912$$

$$\frac{54,912}{2,598,960} = .021$$

Simulated = .022

Four of a kind

$$13 \cdot 48 = 624$$

$$\frac{624}{2,598,960} = .0002$$

Simulated: .0002