



# King High

## Analysis and Report

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### ***Introduction***

This report analyses the proposed casino game King High, using a version of the game under consideration in May 2005. The report is concerned with the expected margin to the casino from the various bets available in the game.

### ***Brief Description of Game***

Cards are dealt in groups of 5 onto the table. The player has several bets available. The first three bets are available before each individual card is drawn.

- High/Low: the player bets that the card drawn will be high (8 to King) or low (Ace to 6). All such bets lose if card is seven.
- Suit: the player bets that the card will be a particular suit, such as Clubs.
- Seven: the player bets that the next card will be a 7.

The remaining bets are available only before the group of 5 cards is dealt.

- Run bet: the player bets that the next cards drawn will be a sequence of 3, 4 or 5 low (or high) cards.
- Jackpot bet: these bets win if certain poker hands are achieved.

### ***High/Low Bet, Single Deck***

A feature of this bet is that the odds change as cards are drawn. A knowledgeable player could note, for example, that several high cards have been drawn and place a maximum bet on a low card to be drawn next. This effect is large enough so that if cards are dealt from a single deck, the deck must be shuffled after each group of five cards. In the table below, the expected margin for the casino is calculated for the first card in a group of 5, and for each succeeding card in a group of five when all preceding cards are high (or low) and a player uses his best strategy. The payout is at even money throughout.

	Casino Margin
First Card	7.69%
Second Card	5.88%
Third Card	4.00%
Fourth Card	2.04%
Last Card	0.00%

Note that after the second card these are not averages but worst cases. The worst case occurs for the fourth card 30% of the time, and for the last card, 15% of the time.

## **High/Low Bet, Multiple Decks, Manual shuffle**

Again we face the problem that it is not possible to play many cards from a shoe without providing opportunities for card counters. With four decks and even money payouts, there is a tiny risk after the 17<sup>th</sup> card. The risk at this stage is more theoretical than real, because 17 high cards or low cards in succession at the beginning of a shoe will occur only about three times in 100,000 shoes. Even after 25 cards, bad cases will occur only about 8 times in 1,000 shoes. In practice, it would be safe to play up to six groups of five cards from a four deck shoe. Card counters would lose patience waiting for a favourable opportunity to arise. With six decks, danger comes more slowly, but with more generous payouts, it comes more quickly.

## **High/Low Bet, Shuffling Machines**

If each group of five cards is placed back in the machine after play, then the composition of the cards in the machine never varies much from the original distribution. Hence the high/low bet remains profitable continually. My knowledge of the machines is incomplete, so that I am not sure how soon replaced cards can reappear from the machine. The analysis below is done on the basis that cards from one group of 5 cannot appear in the next group of 5, but can reappear after that. The discussion in the previous section shows that even if this is inaccurate, and cards are out of play for the next 10 or 15 cards, the consequences are not serious.

The table below shows the results for two different payout situations. The second column is for even money payouts, the third column is for the case where Ace or King is paid at 3 to 2. The figures in the columns show the casino profit. Note that the average profit against players who are not counting cards remains at the figure at the top of the column, such as 3.85% for the more generous payout situation. The lower figures are worst cases and apply if exposed cards are either all high or all low and the player is smart. The fourth column shows the probability of this occurring. The profit can drop as more cards are exposed, but the extreme cases are not frequent.

Because cards are being replaced, the situation does not get worse than shown in the table.

Card	Even Money	3:2 for A & K	Worst case prob
1	7.69%	3.85%	1
2	7.40%	3.54%	1
3	7.10%	3.23%	57.26%
4	6.80%	2.91%	30.93%
5	6.49%	2.60%	16.53%
6	6.19%	2.28%	8.80%
7	5.88%	1.96%	4.67%
8	5.57%	1.64%	2.47%
9	5.26%	1.32%	1.31%
10	4.95%	0.99%	0.69%

## **Suit Bet**

Here the player bets that the next card drawn will be a particular suit. The standard payout will be at 3:1, but this must be modified somewhere to provide a casino advantage. In this game a reduced payout is used if the 7 of the nominated suit appears.

This bet also has the property that the odds may improve for the smart player as cards are drawn from the deck. In this case she will bet on a suit which has not yet appeared, with improved chances of a win. We look at two cases, where a seven of the chosen suit is paid at even money, or where a seven is played as a standoff.

The table below provides an analysis of this bet, assuming worst cases.

Card	7 standoff	7 even	Prob
1	5.77%	3.85%	1
2	5.47%	3.54%	1
3	5.16%	3.23%	1
4	4.85%	2.91%	1
5	4.55%	2.60%	90%
6	4.23%	2.28%	76%
7	3.92%	1.96%	61%
8	3.61%	1.64%	48%
9	3.29%	1.32%	37%
10	2.97%	0.99%	28%

The analysis applies to a 6-deck shuffling machine. Figures in the table show the casino profit assuming that the player bets on some suit which has not yet appeared. The final column shows the probability that such a suit exists. There is always such a suit until 4 cards have appeared, and even after 9 cards, there is a 28% chance that some suit has not shown up.

## **Seven Bet**

A successful bet pays at 11:1. Again we have a situation where the player's chances are improved on later cards if no seven has appeared. The table analyses these cases:

Cards	Profit
1	7.69%
2	7.40%
3	7.10%
4	6.80%
5	6.49%
6	6.19%
7	5.88%
8	5.57%
9	5.26%
10	4.96%

## **Run Bet**

This bet and the jackpot bet can be made only before the first card in a group of 5 is dealt. In the case of a dealing machine, we need to consider a bet before the first group and a bet before a later group of 5. In the latter case, there can be an imbalance of 1, 3 or 5 high (or low) cards from the previous group when the bet is made, which can change the odds. Five different payout patterns are analysed, as follows:

Option	Run of 3	Run of 4	Run of 5
A	3:1	10:1	20:1
B	2:1	9:1	25:1
C	3:1	8:1	24:1
D	3:1	11:1	20:1
E	4:1	9:1	20:1

For each of these payout patterns, the second column in the table below shows the casino profit for the first group of five from a dealing machine. The final column shows results for the worst case of a later group, which occurs when the previous group of five was all high, or all low. The worst case situation will occur 9% of the time.

Option	First Group	Worst Case
A	9.90%	4.17%
B	7.53%	1.26%
C	6.68%	0.52%
D	7.48%	1.63%
E	7.04%	1.25%

## **Jackpot Bet**

Many different payout patterns are possible here. Here is an analysis of four different patterns for six decks. Patterns A & B pay out less often but big wins are available. Pattern D gives a standoff for any pair, but other winnings are smaller. Pattern C may be a good compromise. Any of these patterns may be fine tuned to alter the house margin.

Hand	Probability	Payout A	Payout B	Payout C	Payout D
Any pair	0.457408				Standoff
Jacks or better	0.140741			1	Standoff
2 pair	0.065558		2	2	1
3 of kind	0.041826	3	3	3	2
Full House	0.003653	20	20	15	10
Flush	0.003524	20	20	15	10
Straight	0.003325	20	20	15	10
4 of Kind	0.001668	50	50	50	50
5 of kind	2.32E-05	5000	2000	500	500
Straight Flush	1.17E-05	5000	5000	1000	1000
Royal Flush	1.30E-06	50000	20000	10000	10000
House Margin		8.1%	5.86%	6.51%	4.90%

Note that in jackpot bets, two patterns may appear simultaneously. For example, with six decks, 2 pair may also be a flush. In these calculations we assume that in cases like that, the higher payout is made, but not the lower.

No precise analysis has been performed for changes in odds after five cards have been dealt from a machine. There will be small effects in various directions. If a flush has been dealt, there will be a slightly greater chance for a flush in a different suit next time, but reduced chances for pairs, threes, full house, fours or fives. If four of a kind has been dealt, there will be slightly increased chances next time for pairs, threes etc, but reduced chance of a straight or flush.