

STEP III, 2005, Q13

13 A pack of cards consists of $n + 1$ cards, which are printed with the integers from 0 to n . A game consists of drawing cards repeatedly at random from the pack until the card printed with 0 is drawn, at which point the game ends. After each draw, the player receives £1 if the card drawn shows any of the integers from 1 to w inclusive but receives nothing if the card drawn shows any of the integers from $w + 1$ to n inclusive.

- (i) In one version of the game, each card drawn is replaced immediately and randomly in the pack. Explain clearly why the probability that the player wins a total of exactly £3 is equal to the probability of the following event occurring: out of the first four cards drawn which show numbers in the range 0 to w , the numbers on the first three are non-zero and the number on the fourth is zero. Hence show that the probability that the player wins a total of exactly £3 is equal to $\frac{w^3}{(w + 1)^4}$.

Write down the probability that the player wins a total of exactly £ r and hence find the expected total win.

- (ii) In another version of the game, each card drawn is removed from the pack. Show that the expected total win in this version is half of the expected total win in the other version.



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