(Answers calculated by RNC — *caveat emptor*.) In some of these examples I'll quote exact *p* values, rather than just saying '$p < 0.05$'. Don't worry about this — since you're operating from tables and I'm doing some of these questions on a computer to save time, I can quote exact *p* values when you can't. If I say '$p = .03$', your tables would show that $p < .05$, but not that $p < .01$. If I say '$p = .125$', your tables would show that the answer is not significant at $p = .1$ (i.e. $p > .1$)… and so on.

Q1 coin — Yes: $\chi^2 = 4.00$, df = 1, $p < .05$.

This is a simple 'goodness-of-fit' χ^2 test with 2 categories, so 1 degree of freedom. It's simple:

category	*observed, O*	*expected, E (based on null hypothesis)*	*$(O-E)^2/E$*
heads	40	50	$10^2/50 = 2$
tails	60	50	$10^2/50 = 2$

$$\chi^2 = \sum \frac{(O-E)^2}{E} = 2 + 2 = 4$$

With $df = 1$, critical value of χ^2 for $\alpha = .05$ is 3.84, so our test is significant at this level (but not at the .01 level, for which the critical value is 6.63). A computer would tell us that $p = .046$.

Q2 rat — Yes: $\chi^2 = 14.29$, df = 1, $p < .001$

Jump up, jump up, and get down. This is a two-way 'contingency' χ^2 test. All the rats either jump up or down (beware — if the up / down numbers didn't add up to the total number of rats, we'd have to add a third category… 'white rats don't jump'.)

Observed values (O):

	females	*males*	
up	16	40	*row 1 total = 56*
down	84	60	*row 2 total = 144*
	column 1 total = 100	*column 2 total = 100*	*overall total (n) = 200*

To work out the expected values, we use the formula

$$E(row_i, column_j) = \frac{R_i C_j}{n}$$

For example, row 1 ('up') has a total of 56; row 2 ('down') has a total of 144; both columns have totals of 100. The total number of observations is 200. Therefore, the expected value for (row 1, column 1) is 56 × 100 / 200 = 28, and so on. So we obtain this:

Expected values (E) under the null hypothesis (no relationship between sex and jumping):

	females	*males*
up	28	28
down	72	72

$(O–E)^2 / E$

	females	*males*
up	$(16–28)^2/28 = 5.143$	$(40–28)^2/28 = 5.143$
down	$(84–72)^2/72 = 2$	$(60–72)^2/72 = 2$

$$\chi^2 = \sum \frac{(O-E)^2}{E} = 5.143 + 5.143 + 2 + 2 = 50.24 = 14.286$$

$$df = (\text{rows} - 1) \times (\text{columns} - 1) = (2 - 1) \times (2 - 1) = 1$$

Our χ^2 is therefore significant at the 0.001 level. (A computer would tell us that $p = 0.000157$.)

Q3 crash Yes: $\chi^2 = 482.36$, df = 1, $p < .001$ (exact $p = 6.56 \times 10^{-107}$).

Explanation: two categories. Expected values are 1000 (Sundays), 6000 (days other than Sundays).

Q4 die No: $\chi^2 = 8.67$, df = 5, NS (exact $p = .123$).

Q5 giraffe Yes: $\chi^2 = 30.5$, df = 6, $p < 0.001$ (exact $p = 3.2 \times 10^{-5}$).