Hypothesis Testing (Binomial)

SCAN ME

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1 A game at a school fair states that 30% of players will win a prize.

Winnie claims that the statement is false and that in fact the true percentage of players who will win a prize is less than 30%.

Winnie observes the next 40 players of the game and records that 7 of those players win.

(a) Stating your hypotheses clearly, test Winnie's claim at a 5% level of significance. **(4)**

(b) For the test in part (a)
(i) write down the p-value **(1)**
(ii) find the critical region **(2)**
(iii) find the actual level of significance **(1)**

(Total for Question 1 is 8 marks)

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2 A fair 6-sided dice can land on the numbers 1, 2, 3, 4, 5, or 6.

Gemma rolls the dice once and records the number it lands on.

(a) Write down the name of the distribution that can be used to model the number that the dice lands on. **(1)**

Harpreet rolls the dice 10 times and records the number of times she rolls the number 6.

(b) Find the probability that Harpreet rolls the number 6
(i) once **(1)**
(ii) more than once **(2)**

Rauri suspects that the dice may not be fair and in fact be biased towards the number 6

Rauri tests the dice by rolling it 90 times and he records the number 6 a total of 22 times.

(c) Carry out a suitable test to determine whether the dice is biased towards the number 6.
You should state your hypotheses clearly and use a 5% level of significance. **(4)**

(Total for Question 2 is 8 marks)

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3 A revision website claims that 60% of the students who pay to use the site will achieve a grade A*

Sofia believes that the true proportion of students achieving an A* is less than 60%.

She collects data from a random sample of 30 students who used the website and finds that 13 of them achieved a grade A*.

(a) State suitable hypotheses to test Sofia's claim. **(1)**

(b) Carry out a hypothesis test at a 10% level of significance to determine whether there is evidence that the proportion of students achieving a grade A* is less than 60%. **(3)**

(c) Write down the p-value for the test in part (b) **(1)**

(d) Find the acceptance region for the test in part (b) **(2)**

(Total for Question 3 is 7 marks)

4 It is known that 16% of visitors to a company's website will purchase a product.

A website designer claims that if the company changes the website layout, the proportion of visitors who purchase a product will increase.

The company changes the website layout as suggested and tracks whether the next 200 visitors purchase a product or not.

The company carries out a hypothesis test, at a 5% level of significance, to test the website designer's claim.

(a) State suitable hypotheses for the test. **(1)**

(b) Find the critical region for the test. **(2)**

The company observes that 44 of the 200 visitors purchased a product.

(c) State the conclusion of the hypothesis test. **(1)**

(d) Find the actual level of significance for the test. **(1)**

(Total for Question 4 is 5 marks)

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5 Data from a school shows that each week, 8% of the students receive a detention.

One week, the headteacher selects a sample of 25 students.

(a) State a suitable distribution to model the number of students in the sample who receive a detention. **(1)**

(b) Find the probability that from the sample
(i) no students receive a detention **(1)**
(ii) less than 3 students receive a detention. **(1)**

The headteacher believes that with a new behaviour policy the proportion of students receiving a detention in a week will decrease.

After the introduction of the new policy, a new sample of 50 students is taken and the headteacher finds that 1 student received a detention.

(c) Carry out a suitable test to determine whether the proportion of students receiving a detention has decreased. You should state your hypotheses clearly and use a 10% level of significance. **(4)**

(Total for Question 5 is 7 marks)

6 A train operator claims that 95% of their trains arrive on time.

Thomas believes that the true proportion of trains that are on time is lower than 95%

He decides to take a random sample of 20 trains to see if they are on time or not.

(a) Suggest a suitable distribution to model the number of trains from the sample that are on time. **(1)**

(b) State an assumption that you have made when modelling the distribution in part (a) **(1)**

Using his sample, Thomas carries out a hypothesis test, at a 1% level of significance, to test the train operator's claim.

(c) State suitable hypotheses that Thomas could use. **(1)**

(d) For the hypothesis test, find
(i) the critical region **(2)**
(ii) the acceptance region **(1)**
(iii) the actual significance level **(1)**

Thomas observes that 17 of the trains from the sample are on time.

(e) State the conclusion of the hypothesis test. **(1)**

(Total for Question 6 is 8 marks)

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7 During training sessions, a tennis player faults on their first serve 28% of the time.

During a match, the player takes 85 first serves and faults on 32 of them.

(a) Carry out a suitable test to determine if the proportion of first serves that are faults in matches is different to that in training sessions.
You should state your hypotheses clearly and use a 5% level of significance. **(4)**

(b) Write down the p-value for the test in part (a) **(1)**

During another match, the tennis player serves 72 first serves.

Another hypothesis test is carried out, at the 5% level of significance, to determine if the proportion of first serves that are faults in matches is different to that in training sessions.

(c) Find the acceptance region for this new hypothesis test. **(3)**

(Total for Question 7 is 8 marks)

8 Data shows that 11% of people in the UK are left-handed.

A random sample of 1000 people from the UK is taken and they are asked if they are left-handed.

(a) Suggest a suitable distribution to model the number of left-handed people in the sample. **(1)**

(b) Find the probability that from the sample
(i) less than 100 are left-handed **(1)**
(ii) at least 110 are left-handed **(2)**

Jeremy wants to test if the proportion of people in his city that are left-handed is different to that of the UK.

Jeremy randomly samples 90 people and finds that 4 of them are left-handed.

(c) Carry out a suitable test to determine if the proportion of people in Jeremy's city that are left-handed is different to that of the UK.
You should state your hypotheses clearly and use a 5% level of significance. **(4)**

(Total for Question 8 is 8 marks)

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9 A pharmaceutical company states that when taking a particular medicine, 1 in 10 patients will experience side effects.

A doctor claims that the proportion of patients experiencing side effects when taking this medicine is different to that stated by the pharmaceutical company.

The doctor samples their next 68 patients who take this medicine and records how many experience side effects.

(a) State the type of sampling method used by the doctor. **(1)**

To test their claim the doctor carries out a hypothesis test, at the 5% level of significance.

(b) State suitable hypotheses that the doctor could use. **(1)**

(c) Find the critical region for this test.
You should state the probability associated with each tail, which should be as close to 2.5% as possible. **(4)**

(d) Find the actual level of significance for the test. **(1)**

The doctor observed that 5 of the 68 patients experienced side effects.

(e) State the conclusion of the hypothesis test. **(1)**

(Total for Question 9 is 8 marks)

10 A skincare company claims that 4 in 5 users of their product reported "visibly better skin".

An advertising standards organisation decided to conduct a hypothesis test, at the 1% level of significance, to investigate if the true proportion differed from 4 in 5 users.

A random sample of 45 users of the product was taken and they were asked if they had "visibly better skin".

(a) State suitable hypotheses that the advertising standards organisation could use for this test. **(1)**

(b) Find the critical region for this test.
You should state the probability associated with each tail, which should be as close to 0.5% as possible. **(4)**

(c) Find the actual level of significance for the test. **(1)**

The advertising standards organisation observed that 27 of the 45 users of the product reported "visibly better skin".

(d) State the conclusion of the hypothesis test. **(1)**

(Total for Question 10 is 7 marks)

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