

8.3 Carrying Out a Chi-Square Test for Goodness of Fit

Name: _____ Class: _____ Date: _____

Total: 8 marks

Objective

Build the skills to answer exam questions on **carrying out a chi-square goodness-of-fit test**.

You must be able to:

- compute $\chi^2 = \sum \frac{(O - E)^2}{E}$ with degrees of freedom = $k - 1$
- find the **p-value** and reach a decision
- state a conclusion in context

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ The procedure

1. State the hypotheses and check conditions (all expected counts ≥ 5).
2. Compute $\chi^2 = \sum \frac{(O - E)^2}{E}$, with $df = k - 1$ (categories minus 1).
3. Find the **p-value** from the chi-square distribution.
4. Compare to α and conclude **in context**.

A **large** χ^2 gives a **small** p-value —stronger evidence against the claimed distribution.

■ A worked statistic

For observed (18, 12, 30) and expected (20, 20, 20),

$$\chi^2 = \frac{(18 - 20)^2}{20} + \frac{(12 - 20)^2}{20} + \frac{(30 - 20)^2}{20} = 0.2 + 3.2 + 5.0 = 8.4,$$

with $df = 3 - 1 = 2$. This gives a p-value $\approx 0.015 < 0.05$ – reject the claimed distribution.

2 Practice

2.1 State the degrees of freedom for a goodness-of-fit test with k categories. [1]

2.2 State what a large chi-square value suggests. [1]

2.3 A goodness-of-fit test gives a p-value of 0.03 at $\alpha = 0.05$. State the decision. [1]

3 Exam-style questions

3.1 The degrees of freedom for a goodness-of-fit test with 6 categories is [1]

- **A** 6
 - **B** 5
 - **C** 4
 - **D** 1
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3.2 A large chi-square statistic gives a _____ p-value. [1]

- **A** large
 - **B** small
 - **C** zero
 - **D** negative
-

3.3 A goodness-of-fit test of a die (6 faces) gives $\chi^2 = 15$ with $df = 5$ and p-value 0.01.

(a) State the degrees of freedom. [1]

(b) State the decision at $\alpha = 0.05$. [1]

(c) State the conclusion in context. [1]

4 Go further

- work through the **8.3 Carrying Out a Chi-Square Test for Goodness of Fit** lesson on the **Learn** page;
- read the **Inference for Categorical Data: Chi-Square** section of the AP Statistics handout on the **Know** page.

Solutions

2.1 $k - 1$.

2.2 a large difference between observed and expected counts (evidence against H_0).

2.3 reject H_0 ($0.03 < 0.05$).

3.1 B.

3.2 B.

3.3 (a) 5. (b) reject H_0 . (c) there is convincing evidence the die does not follow the claimed (fair) distribution.