

**Goodness of Fit Tests (Year 1) (From OCR 4768)**

**Q1, (Jun 2010, Q3b)**

$H_0$ : Stock market prices can be modelled by Benford's Law.

$H_1$ : Stock market prices can not be modelled by Benford's Law.

Prob	0.301	0.176	0.125	0.097	0.079	0.067	0.058	0.051	0.046
Exp f	60.2	35.2	25.0	19.4	15.8	13.4	11.6	10.2	9.2
Obs f	55	34	27	16	15	17	12	15	9

$$\begin{aligned} \chi^2 &= 0.44917 + 0.04091 + 0.16 + 0.59588 + 0.04051 \\ &\quad + 0.96716 + 0.01379 + 2.25882 + 0.00435 \\ &= 4.5305(9) \end{aligned}$$

Refer to  $\chi^2_8$ .

Upper 5% point is 13.36.

Not significant.

Suggests Benford's Law provides a reasonable model in the context of share prices.

- M1 Probs  $\times$  200 for expected frequencies.  
All correct.
- M1 Calculation of  $\chi^2$ .
- A1 c.a.o.
- M1 Allow correct df (= cells - 1) from wrongly grouped table and ft. Otherwise, no ft if wrong.  
 $P(\chi^2 > 4.53059) = 0.80636$ .
- A1 No ft from here if wrong.
- A1 ft only c's test statistic.
- A1 ft only c's test statistic.

[7]

**Q2, (Jan 2013, Q4b)**

$H_0$ : The random number function is performing as it should.

$H_1$ : The random number function is not performing as it should.

All expected frequencies are 10

$$\begin{aligned} \chi^2 &= 1.6 + 0.4 + 0.1 + 1.6 + 0.4 + 0.1 + 2.5 + \\ &\quad 2.5 + 1.6 + 1.6 \\ &= 12.4 \end{aligned}$$

Refer to  $\chi_9^2$ .

Upper 10% point is 14.68.

Not significant.

Insufficient evidence to suggest that the random number function is not performing as it should.

B1	Both hypotheses. Must be the right way round. Allow use of the uniform distribution/model. Do not accept "data fit model" oe.
B1	
M1	Calculation of $\chi^2$ .
A1	c.a.o.
M1	Allow correct df (= cells - 1) from wrongly grouped table and ft. Otherwise, no ft if wrong. $P(\chi^2 > 12.4) = 0.1916$ .
A1	No ft from here if wrong.
A1	ft only c's test statistic.
A1	ft only c's test statistic. Conclusion in context. Allow in terms of the uniform distribution/model. Do not accept "data fit model" oe.
<b>[8]</b>	

**Q3, (Jun 2016, Q2a)**

$H_0$ : The (genetic) model fits the data.

$H_1$ : The (genetic) model does not fit the data

Observed	125	37	32	6
Expected	112.5	37.5	37.5	12.5

Cont's	1.3889	0.0067	0.8067	3.38
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$$X^2 = 5.582$$

Degrees of freedom = 3

Critical value = 9.348

$5.582 < 9.348 \rightarrow$  cannot reject  $H_0$

The data give no reason to doubt the genetic model

B1	Both hypotheses; Not 'data fits model'
B1	Expected values correct
M1	use of $(O-E)^2/E$ (at least one correct)
A1	all correct to 3dp where appropriate
A1	cao (3sf or 4sf)
B1	no FT if wrong (can be implied by 9.348)
B1	no FT if wrong
M1	FT their $X^2$
E1	Do not accept data fits model; but 'Evidence suggests that model first the data' is fine
[9]	

**Q4, (Jun 2017, Q2ii)**

$H_0$ : Judges awarded the same number of each mark.  
 $H_1$ : Judges did not award the same number of each mark.

observed	5	6	10	9	14	16	14	6
expected	10	10	10	10	10	10	10	10

$$\chi^2 = 2.5 + 1.6 + 0 + 0.1 + 1.6 + 3.6 + 1.6 + 1.6$$

$$= 12.6$$

Refer to  $\chi^2_7$

The 10% critical value is 12.02.

12.6 > 12.02 so significant

There is sufficient evidence that judges have not been awarding the same number of each mark.

B1

Both hypotheses. Must be in correct context. Allow 'uniform distribution' or 'in equal proportions'. 'Model fits data' or 'belief is justified' is ok. Do not accept 'data fits model' oe'.

B1

For expected frequencies.

M1

Calculation of  $\chi^2$ . (if 12.6 not seen, must see evidence of calculation)

A1

cao.

M1

No ft if wrong.

A1

No ft if wrong.

M1

ft their test statistic

A1

Must be in context and mention 'evidence'. ('organiser's belief' is sufficient context)

**[8]**

**Q5, (OCR 4734, Jun 2014, Q2)**

$H_0$ : The data can be modelled by the theory	B1	For both	Allow compatible.
$H_1$ : The data can't be modelled by the theory.			
Expected values 918, 306, 306, 102	B1	Can be implied by 7.43	
TS = $\frac{(865 - 918)^2}{918} + \dots$	M1		
= 7.43	A1		
TS < 7.815, do not reject $H_0$	M1	ft TS	
There is insufficient evidence to conclude that the data can't be modelled by the theory	A1	ft TS	p>0.05 do not reject $H_0$ p=0.05939 and conclusion
	<b>[6]</b>		

**Q6, (OCR 4734, Jun 2012, Q7i)**

<p><math>H_0: p_1 = p_2 = p_3 (=1/3)</math>, <math>H_1</math>: Not all equal oe eg in words</p> <p>E-values all 30  <math>\chi^2 = (1^2 + 5^2 + 4^2)/30</math>  <math>= 1.4</math>                  (Critical value = 5.991)                  Compare <math>\chi^2</math> with CV and do not reject <math>H_0</math>. Insufficient evidence that groups not randomly chosen.oe</p>	<p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1ft</p> <p><b>[6]</b></p>	<p><math>p = \frac{1}{3}</math> only insufficient.</p> <p>Accept 1.39, 1.399 etc</p> <p>With valid comparison                  or Accept that groups randomly chosen.</p>	
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