A Level Statistics

AQA Past Exam Questions

TOPIC: Hypothesis Testing
One Way ANOVA

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have retrievable mathematical formulae stored in them.

Instructions

• Use **black** ink or ball-point pen.

• If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.

• **Fill in the boxes** at the top of this page with your name, centre number and candidate number.

• Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.

• Answer the questions ***on paper***

• You should show sufficient working to make your methods clear. Answers without working may not gain full credit.

• Unless otherwise stated, statistical tests should be carried out at the 5% significance level.

• When a calculator is used, the answer should be given to three significant figures unless otherwise stated.

Information

• ***You may use the*** booklet 'Statistical Formulae and Tables'

• There are **8** questions in this question paper. The total mark for this paper is ***88***

• The marks for **each** question are shown in brackets – use this as a guide as to how much time to spend on each question.

Advice

• Read each question carefully before you start to answer it.

• Try to answer every question.

• Check your answers if you have time at the end.

• If you change your mind about an answer, cross it out and put your new answer and any working underneath.

• Check your answers if you have time at the end.

AQA_JUNE_2018_2

An environmental protection agency decided to investigate the bioaccumulation of mercury in otters.

Otter carcasses were obtained from three areas of Scotland during 2014.

The concentration of mercury, in milligrams per kilogram, was measured in the livers of otters obtained from random selections of otter carcasses found in each of the three areas.

The results are summarised in the table.

	Area of Scotland	
Shetland	**Argyll**	**North Central**
9.16	13.86	9.02
12.14	14.76	9.85
11.40	16.98	8.13
9.55	14.74	10.40
10.47	13.74	8.10
11.51	9.13	10.22

Carry out a one-factor analysis of variance, using the 5% level of significance, to investigate for a difference between the mean concentrations of mercury in otters for the three different areas of Scotland. You should interpret your conclusion fully in the context of the question.

[11 marks]

AQA_JUNE_2017_5

Researchers set up a trial to investigate the effect of taking a vitamin supplement on a particular auto-immune disease.

Twenty-three adults, all of whom were at the same stage of the disease, were randomly allocated to receive one of three treatments:

- 'None' no vitamin supplement
- 'TR1' a supplement of 750 International Units (IU) of the vitamin per day
- 'TR2' a supplement of 10 500 IU of the vitamin per day.

After six months of the trial, each adult had a blood test to measure the level of immune cells. A lower measurement indicated that the disease was progressing more slowly. Table 6 gives the results of the blood test and the treatment allocated for each adult in the trial.

Table 6

Adult	Treatment allocated	Level of immune cells
A	TR1	720
B	TR2	650
C	None	820
D	None	940
E	TR1	900
F	TR1	790
G	TR1	920
H	None	930
I	TR2	710
J	None	880
K	None	860
L	TR2	690
M	TR2	710
N	TR1	840
O	TR1	870
P	None	790
Q	TR1	810
R	TR1	900
S	TR2	620
T	TR1	840
U	None	850
V	TR2	700
W	TR2	830

The sample of adults may be regarded as random and the level of immune cells, for each treatment, is normally distributed. Investigate for a difference between the three treatments, with regard to the mean level of immune cells, for adults with the disease. Use the 1% level of significance.

[14 marks]

AQA_JUNE_2016_1

The length of time before the deadline when a piece of biochemistry coursework was handed in by each of 19 university students was recorded.

The mark, expressed as a percentage, that each student was subsequently awarded for their coursework was also recorded.

The results are summarised in the table.

Length of time before the deadline			
24 hours or more	**12 hours or more but less than 24 hours**	**2 hours or more but less than 12 hours**	**Less than 2 hours**
66.3	68.5	61.8	58.4
63.2	71.6	67.1	61.9
67.5	64.2	59.7	55.8
72.1	65.3	52.2	65.6
76.2	59.1	62.4	

(a) Carry out a one-factor analysis of variance, using the 5% level of significance, to investigate for a difference in mean mark awarded for the four different time categories.

[10 marks]

(b) State two assumptions that must be made about the given data in order for the analysis in part (a) to be valid.

[2 marks]

AQA_JUNE_2015_3a

A home-improvement company is considering selecting a single provider for the printing of its publicity leaflets. The company uses sixteen different publicity leaflets for marketing the various types of home improvement offered.

Currently, four printing providers, A, B, C and D, are used.

It was decided that four leaflets would be allocated at random to each of the four current providers for printing.

The company then checked the printed publicity leaflets and gave each of them a score, out of a maximum of 75 marks, for quality. A higher score indicates a better quality of printing.

Unfortunately, one of the leaflets from printing provider D was lost by the delivery courier and therefore could not be allocated a score.

The results are given in the table.

Printing provider			
A	**B**	**C**	**D**
46	45	44	58
49	48	36	54
52	50	34	47
50	56	32	

(i) Carry out a one-way analysis of variance, using the 1% level of significance, to investigate for a difference in the mean printing quality scores between the four providers.

[10 marks]

(ii) Interpret your conclusion to the test in part (a)(i) in the context of the question. You should include advice to the company regarding which of the printing providers it should select.

[2 marks]

(iii) State two assumptions that are necessary in order for the test in part (a)(i) to be valid.

[2 marks]

AQA_JUNE_2013_3

A treatment for cotton thread is being tested by a large company.

The treatment increases the breaking strength of the thread. The treatment can be applied at three different levels: low, medium and high.

Sixteen lengths of cotton thread are obtained and are randomly assigned to have low level treatment, medium level treatment or high level treatment.

The breaking strengths, in grams, for the 5 lengths of thread assigned to have the low level treatment are

18.5 16.4 16.6 17.3 17.0

The breaking strengths, in grams, for the 6 lengths of thread assigned to have the medium level treatment are

18.3 17.4 18.5 18.3 17.2 18.9

The breaking strengths, in grams, for the 5 lengths of thread assigned to have the high level treatment are

18.1 16.8 17.4 16.3 17.0

Breaking strengths can be assumed to be normally distributed with a common variance.

(a) (i) Carry out a one-factor analysis of variance, using the 5% level of significance, to investigate for a difference in the mean breaking strength between the three thread treatment levels: low, medium and high.

(10 marks)

(ii) What advice would you give the company about its choice of treatment level?

(2 marks)

(b) If the distributional assumption made in order to carry out the test in part (a)(i) were found to be incorrect, state, with a reason, an alternative test that could be used to investigate for a difference in the mean breaking strength between the three thread treatments.

(2 marks)

AQA_JUNE_2012_5a

A researcher carries out investigations into various aspects of sport.

(a) She wishes to investigate the job satisfaction of athletics coaches. An extensive questionnaire is given to a random selection of 17 athletics coaches, and a final job satisfaction score is obtained for each coach. A higher score indicates greater job satisfaction.

The scores for the athletics coaches in three age categories, 20–29 years, 30–49 years and 50 years and over, are given in Table 3.

Table 3

20–29 years	**30–49 years**	**50 years and over**
2.02	2.25	2.28
2.10	2.54	2.55
2.12	2.67	2.65
2.14	2.80	2.90
2.29	2.85	2.96
	2.92	3.05

(i) Carry out a one-factor analysis of variance, using the 1% level of significance, to investigate for a difference in the mean satisfaction scores between the three age categories.

(10 marks)

(ii) Interpret your conclusion in context**.**

(1 mark)

(iii) State one assumption that you made about the given data when carrying out the test in part (a)(i).

(1 mark)

AQA_JUNE_2011_3

A comparative study of the reading attainment of children aged around 10 years was carried out during 2006. The children involved were taught to read by one of three different methods: A, B or C.

The table gives the reading attainment score, on a scale established in 2001, for a random selection of these children, all of whom had undertaken at least four years of formal education. A higher score indicates a higher level of reading attainment.

	Method A	Method B	Method C
Reading attainment score	513 498 457 448 439 502	542 497 501 493	457 429 465 480 466 425 493 432
Total	2857	2490	3190

$$\sum\sum x_{ij} = 4\ 067\ 243$$

(a) Use a one-factor analysis of variance to investigate, at the 5% level of significance, for a difference between the three teaching methods.

(9 marks)

(b) State two assumptions that you made in order to carry out the test in part (a).

(2 marks)