A Level Statistics
AQA Past Exam Questions

TOPIC: Experimental Design

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 ***90***

• 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_2015_1

The plant Ginkgo biloba has been used safely in traditional medicine for thousands of years. Researchers wanted to carry out a trial in order to discover whether Ginkgo biloba could be used to treat symptoms of early-stage dementia caused by Alzheimer's disease. The design for the researchers' trial is outlined in the following bullet points.

* 300 early-stage dementia sufferers volunteered to take part in the trial. It was required that approximately half of these volunteers received Ginkgo biloba and the remainder did not.
* The researchers provided all of the volunteers with tablets. The volunteers who were allocated to receive Ginkgo biloba were given tablets that contained Ginkgo biloba extract and the volunteers who were not allocated to receive Ginkgo biloba were given tablets, of identical size and colour, that contained inactive ingredients.
* During the trial, neither the volunteers nor the researchers knew which tablets contained Ginkgo biloba extract and which tablets contained inactive ingredients.
* Following the 52-week trial, the researchers then assessed dementia symptoms for all the volunteers.

(a) Describe a method that could be used to allocate the volunteers to receive Ginkgo biloba.

[2 marks]

(b) Identify, for the trial, which volunteers formed:

(i) the experimental group;

(ii) the control group.

[2 marks]

(c) (i) Justify the decision made by the researchers to provide all of the volunteers with tablets.

(ii) Explain why, during the trial, it was beneficial that neither the researchers nor the volunteers knew which tablets contained Ginkgo biloba.

[4 marks]

AQA_JUNE_2012_1

An investigation into the effect of a particular chemical on ripening times of fruit in cold storage is carried out by a company that stores apples of three varieties: Red Delicious, Golden Delicious and Pink Lady.

The chemical is applied to three apples, one of each variety, selected at random from those that are to be kept in cold storage.

Three further apples, again one of each variety, are selected at random from those that are to be kept in cold storage. These apples are not treated with the chemical.

In addition to the chemical, it is believed that the variety of an apple might influence its time to ripening.

The length of time to ripening is measured for the six apples in the investigation.

(a) Identify those apples that constitute the control group.

(1 mark)

(b) Explain the purpose of selecting apples for treatment with the chemical at random from those to be kept in cold storage.

(1 mark)

(c) Name the technique that you would use in order to analyse the data obtained from this investigation.

(2 marks)

(d) Name the blocking factor.

(1 mark)

AQA_JUNE_2013_2

Semiconductor wafers are produced in large batches at a manufacturing facility. Individual wafers then receive doses of an implant material in a diffusion process that takes place in a furnace. Engineers are to investigate whether different wafer-implant-material doses have a significant effect on resistivity measurements.

The engineers wish to use four different doses of implant material: D1, D2, D3 and D4.

Twelve wafers, all selected from the same batch, are obtained for this investigation.

As only four wafers can be allowed in any one furnace run, the wafers will have to be tested in three different furnace runs: F1, F2 and F3.

(a) (i) Name the blocking factor.

(ii) Name the treatment factor.

(iii) Give a reason why the 12 wafers should be chosen from the same batch.

(4 marks)

(b) One engineer, Eric, suggests using a completely randomised design for this experiment. Another engineer, Harriet, suggests using a randomised block design.

(i) Explain why Harriet's suggestion is preferable to Eric's suggestion.

(2 marks)

(ii) Complete Table 1 below to illustrate Harriet's suggestion for the design of this experiment.

(2 marks)

(c) Name the technique that you would use in order to analyse data obtained from an experiment using Harriet's suggested design.

(2 marks)

Table 1

Furnace run		
F1	**F2**	**F3**

AQA_JUNE_2014_4

The pharmaceutical company, Abetter, wishes to test the effectiveness of a new safe vaccine developed to immunise people against the common cold. The new vaccine is to be tested against a placebo vaccine.

To test the vaccine using a pilot study, Abetter has 20 volunteers, A, B, C, ..., T. The sex and age of each of these volunteers are shown in the table.

Volunteer	A	B	C	D	E	F	G	H	I	J
Sex	M	M	M	M	M	M	M	M	M	M
Age (years)	23	42	35	25	61	44	54	35	57	66

Volunteer	K	L	M	N	O	P	Q	R	S	T
Sex	F	F	F	F	F	F	F	F	F	F
Age (years)	42	62	56	24	33	47	28	67	51	34

The three suggested designs for this investigation are completely randomised, randomised block and matched pairs.

(a) Produce a table layout, together with an explanation, to indicate how Abetter should allocate the 20 volunteers to the two treatments of placebo vaccine and new vaccine so that the design is:
(i) completely randomised; (ii) randomised block; (iii) matched pairs.

[6 marks]

(b) Give an advantage for the investigation of using a design that is:
(i) completely randomised; (ii) randomised block; (iii) matched pairs.

[3 marks]

(c) State, with a reason, which one of the three designs you would recommend to Abetter for this investigation.

[2 marks]

AQA_JUNE_2016_3

As part of an investigation into weight loss diets, sixteen men, all of whom were approximately 15 kilograms overweight, were chosen.

Four men were chosen randomly from each of the age groups 20–29 years, 30–39 years, 40–49 years and 50–59 years.

Each man within an age group was assigned at random to a different one of four types of diet, D1, D2, D3 and D4. Each diet provided exactly the same number of calories per day.

(a) (i) Identify the blocking factor for this investigation.

(ii) Identify the treatment factor for this investigation.

(iii) Explain the purpose of a blocking factor in such an investigation.

[4 marks]

(b) The weight loss achieved for each man in this investigation was recorded.

(i) Construct a fully labelled table that could be used to record the weight losses achieved by the men in this investigation.

(ii) State the type of experimental design used in this investigation.

(iii) Name the technique that you would use in order to analyse the data obtained from this investigation.

[6 marks]

AQA_JUNE_2017_3

A professional cycling team has been using the cycle-chain lubricant L1 for a number of years.

The company that produces L1 claims that its new lubricant, L2, further reduces friction between chain links thus resulting in faster race times.

The team's engineers decide to carry out an experiment to investigate this claim. They also decide to test two competitor brand lubricants, L3 and L4.

The team has four cyclists all of whom help with the experiment by each completing four 5000 metre rides.

Before starting the experiment, the lead engineer, Heather, puts the lubricants in unlabelled bottles, so that she alone knows which lubricant is in which bottle.

For each ride, Pete, another engineer, applies a set quantity of one lubricant to a clean chain on a cycle. The ride is then timed over 5000 metres in an indoor velodrome.

(a) (i) Explain, in the context of the question, what is meant by the term 'double blind' experiment.

(ii) Explain why a double blind experiment is beneficial for investigating the company's claim.

[4 marks]

(b) For this experiment, Pete suggests that lubricants should be randomly allocated, for each ride, to each cyclist.

(i) State the name of Pete's suggested experimental design.

(ii) Name an alternative experimental design, preferable to Pete's design, that could be used for this experiment. You should include an explanation regarding why this alternative design is preferable.

(iii) Construct a table that identifies how the four lubricants should be allocated to the cyclists and rides using the alternative design that you named in part (b)(ii).

[5 marks]

(c) Name a statistical analysis that Heather could undertake on the race times recorded if the alternative design that you named in part (b)(ii) is used.

[1 mark]

AQA_JUNE_2018_4

Mariam, an ecologist, is interested in the effect of the local environment on the growth of pine saplings. She wishes to study the effect of 3 different environments, E_1 , E_2 and E_3 on the mean growth of pine saplings.

Mariam's colleague, Paolo, obtains 9 saplings, S_1, S_2 ….. S_9, for her study.

(a) (i) Construct a fully labelled table to illustrate a suitable experimental design for Mariam to use in her study.

(ii) State the name of the experimental design indicated by your table in part (a)(i). (iii) State the name of the technique that Mariam would need to use to analyse the data collected using the experimental design that you stated in part (a)(ii).

[5 marks]

(b) Paolo later informs Mariam that the pine saplings he obtained for her study were of three different varieties.

- Saplings S_1, S_2 and S_3 were of variety V_1 .
- Saplings S_4, S_5 and S_6 were of variety V_2 .
- Saplings S_7, S_8 and S_9 were of variety V_3 .

(i) Construct a new fully labelled table to illustrate a different experimental design for Mariam to use, following Paolo's information about the saplings.

(ii) State the name of the experimental design indicated by your table in part (b)(i).

(iii) State the name of the technique that Mariam would need to use to analyse the data collected using the experimental design that you stated in part (b)(ii).

[4 marks]

(c) In light of Paolo's information regarding the pine saplings, state one advantage of the design that you stated in part (b)(ii) over the design that you stated in part (a)(ii).

[2 marks]

AQA_JUNE_2007_2

(a) Explain the meaning and purpose of blind trials.

(3 marks)

(b) A spokesman for a cosmetics company was quoted in an interview as saying, "Carrying out a placebo-controlled test does not make much sense in our industry. A cosmetic product is a balanced and precise mixture of cosmetic ingredients and its effectiveness relies on this specific combination of ingredients." Comment on the validity of this statement.

(2 marks)

AQA_JUNE_2008_2

Sandra, a chemical engineer, wishes to compare four different instrument panels, A, B, C and D, for use in controlling a chemical process. Technicians are to be asked to assess the panels for ease of use. Two experimental designs are suggested.

Design 1 Twelve technicians are randomly allocated, three to each instrument panel.

Design 2 Three technicians each assess each instrument panel. (The order in which they appear in each column is unimportant.)

Design 1				Design 2			
A	B	C	D	A	B	C	D
T_5	T_2	T_{12}	T_4	T_1	T_1	T_1	T_1
T_1	T_6	T_9	T_{11}	T_2	T_2	T_2	T_2
T_7	T_{10}	T_8	T_3	T_3	T_3	T_3	T_3

(a) Identify the completely randomised design.

(1 mark)

(b) Name the other type of experimental design suggested.

(1 mark)

(c) Assuming that there is no difference in the difficulty of carrying out the two designs, explain why Design 2 is preferred to Design 1.

(2 marks)

AQA_JUNE_2009_3

A road haulage firm frequently undertakes journeys between the firm's depot and a customer's factory. The manager wonders whether it is quicker to use the direct route, D, or a route which is longer but consists mainly of motorway, M.

You are asked to design an experiment to compare these two alternative routes. Six lorries, each with its own driver, are available to you on Wednesday and Thursday, and each will make one journey to the factory each day.

(a) Copy and complete the following table indicating which route, D or M, each driver should use.

		Wednesday	Thursday
Driver	1		
	2		
	3		
	4		
	5		
	6		

For example, if you wish driver 1 to travel by the direct route on Wednesday, put a D in the top left hand rectangle of your table. Continue until you have filled in all twelve rectangles.

(3 marks)

(b) Each driver is to be told to start their journey at the same time on Thursday as they did on Wednesday. Suggest a further instruction that you might give the drivers which would help to ensure a fair comparison between routes.

(2 marks)

(c) Suggest an appropriate statistical analysis to be carried out after the journey times have been collected.

(2 marks)

AQA_JUNE_2010_1

In a comparison of scanning speeds of three different models of scanner, X, Y and Z, three different types of document, D1, D2 and D3, are used.

Three experimental designs are suggested.

Design 1			Design 2			Design 3		
X	Y	Z	X	Y	Z	X	Y	Z
D_1	D_2	D_3	D_2	D_1	D_3	D_1	D_2	D_3
D_1	D_2	D_3	D_1	D_3	D_2	D_3	D1	D_1
D_1	D_2	D_3	D_2	D_1	D_3	D_2	D_3	D_2

For example:

Design 1 indicates that three type D2 documents are scanned by scanner model Y;

Design 2 indicates that one type D1 document and two type D2 documents are scanned by scanner model X.

The order in which document types occur in each column is not important.

(a) Write down the name of Design 3.

(1 mark)

(b) State one advantage of Design 3 over Design 2.

(1 mark)

(c) State one disadvantage of Design 1.

(1 mark)

(d) Name the technique that you would use to analyse the data obtained from using Design 3.

(1 mark)

AQA_JUNE_2011_1

A trial was carried out to investigate the effect of an antibiotic treatment for acute ear infections in children aged between 6 months and 2 years. A researcher gave the following description of the trial design.

‘After we obtained consent the children were randomly assigned to treatment with amoxicillin or with a placebo suspension with the same colour and taste. The suspensions were supplied to the participating doctors in a double blind fashion with computerised two block randomisation; doctors, parents and investigators remained blinded throughout the study.’ Source: British Medical Journal, 2000

(a) Explain, in context, the meaning of:

(i) randomly assigned;

(1 mark)

(ii) placebo;

(1 mark)

(iii) double blind.

(1 mark)

(b) Explain the purpose of:

(i) a placebo;

(1 mark)

(ii) a double blind trial.

(1 mark)