A Level Statistics

AQA Past Exam Questions

TOPIC: Hypothesis Testing
Paired t Test

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 ***72***

• 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_3a

Rupal, the Human Resources manager of a large chain of optician stores, was investigating absenteeism and job satisfaction of employees.

Rupal was concerned that the level of absenteeism was too high. In order to try to reduce absenteeism, Rupal introduced a new bonus scheme for employees.

(a) Rupal measured the percentage absenteeism in each of a random sample of 10 stores during a three-month period before the bonus scheme was introduced and also during a three-month period after it was introduced.

The results are given in Table 1.

Table 1

	Store									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Before	5.2	6.1	3.4	6.5	6.8	8.2	6.1	4.8	4.9	3.5
After	4.4	6.4	2.8	4.6	6.5	5.6	5.2	5.7	5.6	1.9

(i) Carry out a t -test, using the 5% level of significance, to investigate whether mean percentage absenteeism reduced following the introduction of the bonus scheme.

[9 marks]

(ii) State any necessary assumption for the test in part (a)(i) to be valid.

[1 mark]

AQA_JUNE_2017_1a

A scientist investigated the yield of coffee beans obtained from two species of coffee tree: Robusta and Arabica. He believed that Robusta trees would, on average, give a higher yield than Arabica trees.

The scientist planted each of ten plots of land with trees of both species and waited until all the trees were producing fruit.

(a) Two trees, one of each species, were selected randomly from the healthy trees on each plot. The total weight, in grams, of the coffee beans obtained from each of the selected trees was recorded and is given in Table 1.

Table 1

	Plot									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Robusta	623	654	733	704	822	669	980	892	805	762
Arabica	490	550	820	790	680	568	795	725	596	665

Making any necessary assumptions, carry out a paired t-test, using the 1% level of significance, to investigate whether the given data support the scientist's belief.

[8 marks]

AQA_JUNE_2015_2a

The pulse rates, in beats per minute, of a sample of 12 patients who were undergoing the same minor dental treatment, were measured before and immediately after the treatment.

The results are given in Table 1.

Table 1

	Patient											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Pulse rate before	70	64	72	73	75	69	68	72	68	68	70	73
Pulse rate after	75	70	73	73	74	69	73	73	67	63	74	75

It is decided that a paired t-test should be carried out on these data in order to investigate whether average pulse rates differ before and immediately after the minor dental treatment.

(i) State two necessary assumptions in order for a paired t-test on these data to be valid.

[2 marks]

(ii) Carry out this test using the 5% level of significance.

[8 marks]

(iii) State the type of error, if any, that might have occurred in carrying out the t-test in part (a)(ii).

[1 mark]

AQA_JUNE_2016_2a

One box each of two popular brands of chocolates, ‘Quality Chox’ and ‘Chok Delights’, was placed, for staff consumption, on each of 12 wards at a large UK hospital.

As part of an investigation into staff consumption of chocolates whilst at work, these boxes were kept under surveillance and the time at which each chocolate in each box was taken was recorded.

(a) The times taken, to the nearest minute, before the boxes were first opened after they had been placed on the wards, are given in Table 1.

Table 1

	Hospital ward											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Quality Chox	16	18	12	10	18	12	13	13	20	16	19	21
Chok Delights	11	18	8	7	19	13	9	11	12	12	10	19

Making any necessary assumptions, carry out a paired t-test, using the 5% level of significance, to investigate the belief that the time taken for a box of Chok Delights chocolates to be first opened after having been placed on a ward, is, on average, less than that for a box of Quality Chox chocolates.

[10 marks]

AQA_JUNE_2014_1

An investigation was carried out into the colour of the tail feathers of hybrid Northern Flicker birds. Some birds had one odd tail feather that was different in colour or length from the other typical tail feathers because it was regrown after being lost.

The yellowness of the one odd tail feather on each of 16 birds was measured and compared with the yellowness of one typical tail feather from the same bird.

The ‘yellowness index’ of a typical tail feather and that of the odd tail feather were found for each bird. A lower ‘yellowness index’ value indicates a lighter shade of yellow.

The results are given in the table.

		Yellowness index	
		Typical feather	**Odd feather**
Bird	1	-0.255	-0.324
	2	-0.213	-0.185
	3	-0.190	-0.299
	4	-0.185	-0.144
	5	-0.045	-0.027
	6	-0.025	-0.039
	7	-0.015	-0.264
	8	-0.003	-0.077
	9	-0.015	-0.017
	10	-0.020	-0.169
	11	-0.023	-0.096
	12	-0.040	-0.330
	13	-0.040	-0.346
	14	-0.050	-0.191
	15	-0.055	-0.128
	16	-0.058	-0.180

(a) State two assumptions that must be made for a paired t-test on the given data to be valid.

[2 marks]

(b) Using the 1% level of significance, investigate the claim that odd tail feathers are a lighter shade of yellow than typical tail feathers on Northern Flicker birds.

[10 marks]

AQA_JUNE_2013_1a

A podiatrist wishes to investigate the use of an EMC device for measuring the mobility of the first ray of a patient's foot. The EMC device is to be compared with the currently used K device.
Ten patients at a podiatry clinic each had the mobility of the first ray of one of their feet measured by each device. The order in which the devices were used was random.

The measurements obtained, in degrees, are given in the table.

Patient	1	2	3	4	5	6	7	8	9	10
K device	3.2	4.8	3.7	4.5	5.2	3.8	4.2	4.3	4.2	5.7
EMC device	3.6	4.0	4.1	5.0	5.1	4.6	4.7	4.3	4.8	5.6

(i) Carry out a paired t-test, using the 5% level of significance, to investigate for a mean difference between the measurements obtained from the two devices.

(8 marks)

(ii) State the distributional assumption that it was necessary to make in order to make the test in part (a)(i) valid.

(2 marks)

AQA_JUNE_2012_3a

An investigation was carried out into the contents of jars of jam. Eight manufacturers, each of which produced both 'supermarket own' strawberry jam and 'branded' strawberry jam, were asked to provide one jar of each for this investigation.
(a) The jars all had a nominal jam weight of 340 grams. The contents of each jar were weighed and these weights, in grams, are given in Table 1.

Table 1

Type	**Supermarket own**	**Branded**
Manufacturer		
1	351	358
2	349	362
3	355	354
4	343	349
5	352	348
6	348	364
7	353	354
8	346	351

(i) Carry out a paired t-test, using the 10% level of significance, to investigate the claim that, on average, 'branded' jars contain strawberry jam that weighs at most 5 grams more than that contained in 'supermarket own' jars. Interpret your conclusion in context.

(9 marks)

(ii) State the two assumptions that you have made in order for the test in part (a)(i) to be valid.

(2 marks)