A Level Statistics

AQA Past Exam Questions

TOPIC: Correlation Coefficients

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 ***165***

• 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_JAN_2012_2

Dr Hanna has a special clinic for her older patients. She asked a medical student, Lenny, to select a random sample of 25 of her male patients, aged between 55 and 65 years, and, from their clinical records, to list their heights, weights and waist measurements. Lenny was then asked to calculate three values of the product moment correlation coefficient based upon his collected data. His results were:

(a) 0.365 between height and waist measurement;

(b) 1.16 between height and weight;

(c) -0.583 between weight and waist measurement.

For each of Lenny's three calculated values, state whether the value is definitely correct, probably correct, probably incorrect or definitely incorrect.

(3 marks)

AQA_JAN_2013_4

Ashok is a work-experience student with an organisation that offers two separate professional examination papers, I and II.

For each of a random sample of 12 students, A to L, he records the mark, x per cent, achieved on Paper I, and the mark, y per cent, achieved on Paper II.

	A	B	C	D	E	F	G	H	I	J	K	L
X	34	46	53	62	67	72	60	54	70	71	82	85
y	61	66	72	78	88	81	49	60	54	44	49	36

(a) (i) Calculate the value of the product moment correlation coefficient, r, between x and y.

(3 marks)

(ii) Interpret your value of r in the context of this question.

(2 marks)

AQA_JUNE_2012_1

A production line in a rolling mill produces lengths of steel.

A random sample of 20 lengths of steel from the production line was selected. The minimum width, x centimetres, and the minimum thickness, y millimetres, of each selected length was recorded.

The following summarised information was then calculated from these records.

$S_{xx} = 2.030 \quad S_{yy} = 1.498 \quad S_{xy} = -0.410$

(a) Calculate the value of the product moment correlation coefficient between x and y.

(2 marks)

(b) Interpret your value in the context of the question.

(2 marks)

AQA_JAN_2008_2

The head and body length, x millimetres, and tail length, y millimetres, of each of a sample of 20 adult dormice were measured. The following statistics are derived from the results.

$S_{xx} = 1280.55 \quad S_{yy} = 281.8 \quad S_{xy} = 416.3$

(a) Calculate the value of the product moment correlation coefficient between x and y.

(2 marks)

(b) Interpret your value in the context of this question.

(2 marks)

(c) Write down the value of the product moment correlation coefficient if the measurements had been recorded in centimetres.

(1 mark)

(d) Give a reason why it is not generally advisable to calculate the value of the product moment correlation coefficient without first viewing a scatter diagram of the data. Illustrate your answer with a sketch.

(2 marks)

AQA_JUNE_2013_1

The average maximum monthly temperatures, u degrees Fahrenheit, and the average minimum monthly temperatures, v degrees Fahrenheit, in New York City are as follows.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum (u)	39	40	48	61	71	81	85	83	77	67	54	41
Minimum (v)	26	27	34	44	53	63	68	66	60	51	41	30

(a) (i) Calculate, to one decimal place, the mean and the standard deviation of the 12 values of the average maximum monthly temperature.

(2 marks)

(ii) For comparative purposes with a UK city, it was necessary to convert the temperatures from degrees Fahrenheit (^{0}F) to degrees Celsius (^{0}C). The formula used to convert f ^{0}F to c ^{0}C is:

$$c = \frac{5}{9}(f - 32)$$

Use this formula and your answers in part (a)(i) to calculate, in ^{0}C, the mean and the standard deviation of the 12 values of the average maximum monthly temperature.

(3 marks)

(b) The value of the product moment correlation coefficient, r , between the above 12 values of u and v is 0.997, correct to three decimal places. State, giving a reason, the corresponding value of rxy , where x and y are the exact equivalent temperatures in ^{0}C of u and v respectively.

(2 marks)

AQA_JUNE_2017_5

A consumer organisation road-tested 12 new cars to measure each car's actual fuel consumption, x mpg, under normal driving conditions.

For each car, the organisation then used the fuel consumption, u mpg, claimed by the car's manufacturer, to calculate the difference, y mpg, between the car's claimed and actual fuel consumptions. This difference, y= u - x, is called the car's 'mileage mark-up'.

The results are shown in the table.

Car	A1	B1	C1	D1	E1	F1	A2	B2	C2	D2	E2	F2
x	23.6	31.4	38.3	46.3	52.3	60.1	29.8	38.0	45.2	58.0	61.4	67.6
y	10.1	12.3	10.1	10.3	13.6	13.8	13.8	13.2	12.5	12.3	9.4	7.8

(a) (i) Calculate the value of the product moment correlation coefficient between x and y .

[3 marks]

(ii) Assuming that the 12 cars are a random sample, interpret your value in the context of this question.

[2 marks]

(b) In fact, cars A1 and A2 are the same make and model except that A1 has a petrol engine whereas A2 has the equivalent diesel engine.

The same is also the case for the other 5 pairs of cars: B1 and B2, ..., F1 and F2. The summarised data for petrol-engine cars A1 to F1 is as follows.

$$S_{xx} = 916.80 \qquad S_{yy} = 15.46 \qquad S_{xy} = 80.56$$

(i) Calculate the value of the product moment correlation coefficient between x and y for cars A1 to F1.

[2 marks]

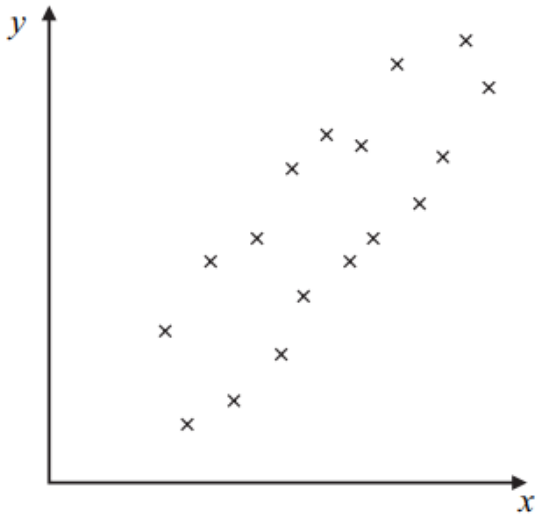
(ii) The value of the product moment correlation coefficient between x and y for the diesel-engine cars A2 to F2 is –0.889 , correct to three decimal places. In the light of this information, together with your answer to part (b)(i), comment on the correlations between the actual fuel consumption and the mileage mark-up for petrol-engine cars and for diesel-engine cars.

[4 marks]

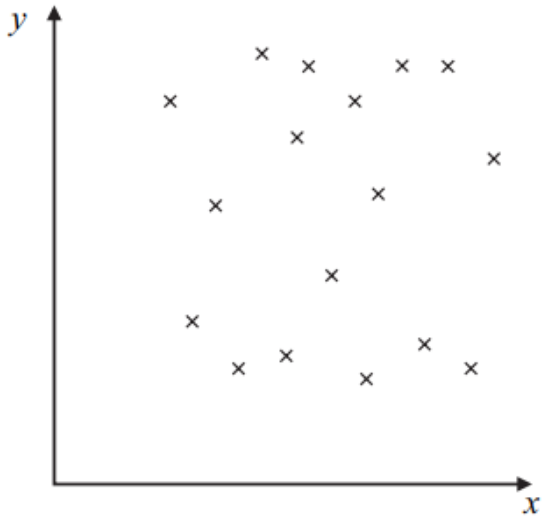
AQA_JAN_2007_3

Estimate, without undertaking any calculations, the value of the product moment correlation coefficient between the variables x and y in each of the three scatter diagrams.

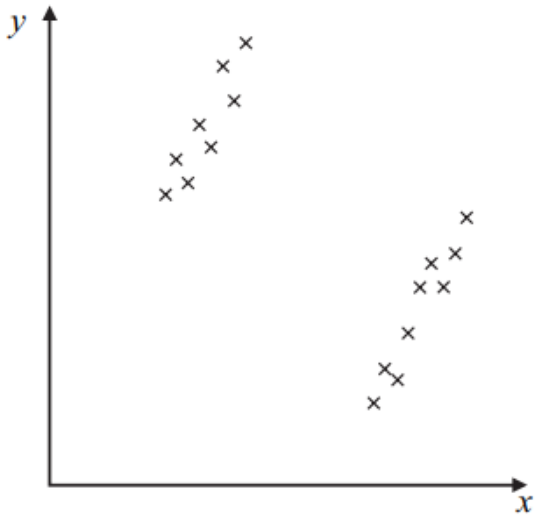
(a)



(b)



(c)



(5 marks)

AQA_JUNE_2007_1

The table shows the length, in centimetres, and maximum diameter, in centimetres, of each of 10 honeydew melons selected at random from those on display at a market stall.

Length	24	25	19	28	27	21	35	23	32	26
Maximum diameter	18	14	16	11	13	14	12	16	15	14

(a) Calculate the value of the product moment correlation coefficient.

(3 marks)

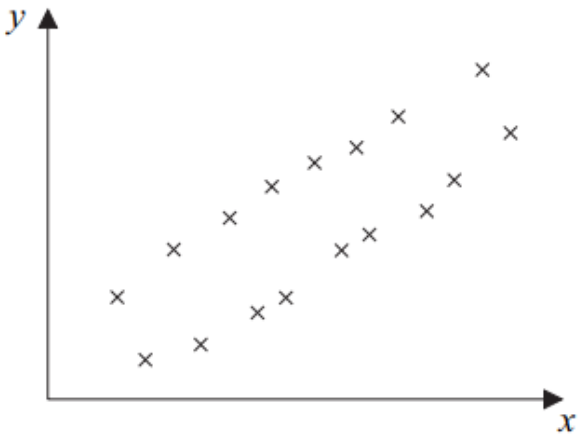
(b) Interpret your value in the context of this question.

(2 marks)

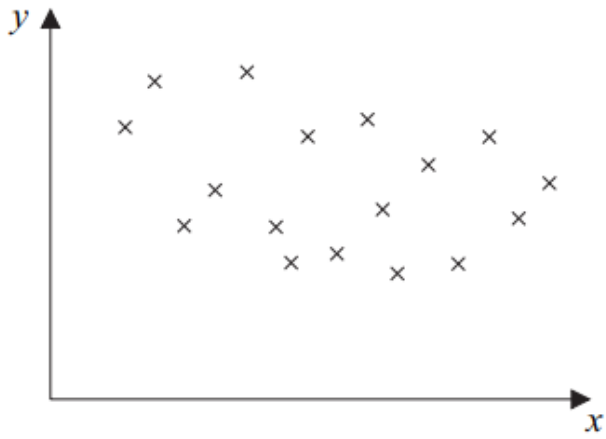
AQA_JAN_2011_1

(a) Estimate, without undertaking any calculations, the value of the product moment correlation coefficient between the variables x and y for each of the two scatter diagrams.

(i)



(ii)



(2 marks)

(b) The table gives the circumference, x centimetres, and the weight, y grams, of each of 12 new cricket balls.

x	22.5	22.7	22.6	22.4	22.5	22.8	22.6	22.7	22.8	22.4	22.9	22.6
y	160.3	159.4	157.8	158.0	157.3	159.8	158.3	159.6	161.3	156.4	162.5	161.2

(i) Calculate the value of the product moment correlation coefficient between x and y.

(3 marks)

(ii) Assuming that the 12 balls may be considered to be a random sample, interpret your value in context.

(2 marks)

AQA_JUNE_2015_3

Fourteen candidates each sat two test papers, Paper 1 and Paper 2, on the same day.
The marks, out of a total of 50, achieved by the students on each paper are shown in the table.

Candidate	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Mark on Paper 1 (x)	36	29	33	17	42	26	45	12	25	19	26	15	28	11
Mark on Paper 2 (y)	46	18	34	24	45	21	37	15	35	17	38	11	44	21

(a) (i) Calculate the value of the product moment correlation coefficient, r, between the marks on Paper 1 and those on Paper 2.
[3 marks]
(ii) Interpret your value in the context of this question.
[2 marks]
(b) It was then discovered that seven of the candidates, Group T, had been given extra tuition in preparation for the tests, whereas the other seven candidates, Group U, had been given only the usual tuition.
The summarised data for the two groups are as follows.

Group T: r = 0.261 $\bar{x}$ = 33.57 $\bar{y}$ = 39.86

Group U: Sxx = 279.71 Syy = 112.86 Sxy = 34.57 $\bar{x}$ = 18.43 $\bar{y}$ = 18.14

(i) For Group U, calculate the value of r.

[2 marks]

(ii) Interpret, in the context of the question, the value of r for each group of candidates.

[2 marks]

(iii) Comment, with justification, on the apparent effect of the extra tuition.

[2 marks]

AQA_JUNE_2011_7

(a) Three airport management trainees, Ryan, Sunil and Tim, were each instructed to select a random sample of 12 suitcases from those waiting to be loaded onto aircraft.
Each trainee also had to measure the volume, x, and the weight, y, of each of the 12 suitcases in his sample, and then calculate the value of the product moment correlation coefficient, r, between x and y.

* Ryan obtained a value of -0.843 .
* Sunil obtained a value of +0.007 .

Explain why neither of these two values is likely to be correct.

(2 marks)

(b) Peggy, a supervisor with many years' experience, measured the volume, x cubic feet, and the weight, y pounds, of each suitcase in a random sample of 6 suitcases, and then obtained a value of 0.612 for r.

* Ryan and Sunil each claimed that Peggy's value was different from their values because she had measured the volumes in cubic feet and the weights in pounds, whereas they had measured the volumes in cubic metres and the weights in kilograms.
* Tim claimed that Peggy's value was almost exactly half his calculated value because she had used a sample of size 6 whereas he had used one of size 12 .

Explain why neither of these two claims is valid.

(2 marks)

(c) Quentin, a manager, recorded the volumes, v, and the weights, w, of a random sample of 8 suitcases as follows.

v	28.1	19.7	46.4	23.6	31.1	17.5	35.8	13.8
w	14.9	12.1	21.1	18.0	19.8	19.2	16.2	14.7

(i) Calculate the value of r between v and w.

(3 marks)

(ii) Interpret your value in the context of this question.

(2 marks)

AQA_JAN_2009_2

A greengrocer sells bunches of 9 carrots at his Saturday market stall. Tom and Geri are two Statistics students who work on the stall. Each selects a bunch of carrots at random.

(a) At home, Tom measures the length, x centimetres, and the maximum diameter, y centimetres, of each carrot in his selected bunch with the following results.

x	16.2	13.1	10.4	12.1	14.6	9.7	11.8	13.6	17.3
y	4.2	3.9	4.7	3.3	3.7	2.4	3.1	3.5	2.7

(i) Calculate the value of the product moment correlation coefficient.

(3 marks)

(ii) Interpret your value in context.

(2 marks)

(b) At her home, Geri measures the length, in centimetres, and the weight, in grams, of each carrot in her selected bunch and then obtains a value of -0.986 for the product moment correlation coefficient. Comment, with a reason, on the likely validity of Geri's value.

(2 marks)

AQA_JUNE_2010_1

The weight, x kg, and the engine power, y bhp, of each car in a random sample of 10 hatchback cars are shown in the table

x	1196	1062	1335	1429	1012	1355	1145	1417	1275	1284
y	123	88	150	158	69	120	94	143	107	128

(a) Calculate the value of the product moment correlation coefficient between x and y.

(3 marks)

(b) Interpret your value in the context of the question.

(2 marks)

AQA_JUNE_2016_1

The table shows the trunk length, x metres, and the tail length, y metres, for each of a sample of 10 male African elephants.

x	2.06	2.07	2.11	1.94	1.96	2.10	2.02	19.2	2.05	2.02
y	1.16	1.19	1.11	1.06	1.13	1.19	1.08	1.10	1.13	1.15

(a) Calculate the value of the product moment correlation coefficient between x and y .

[3 marks]

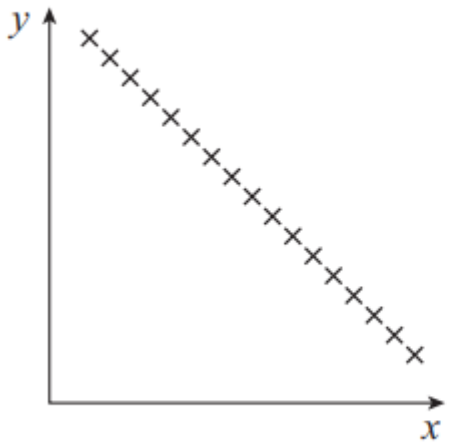
(b) Assuming that the 10 elephants are a random sample, interpret your value in the context of this question.

[2 marks]

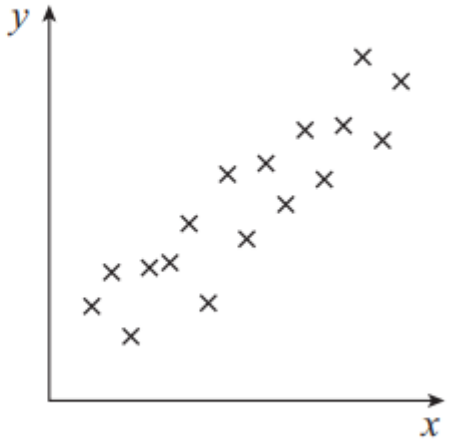
AQA_JUNE_2018_1

(a) Estimate, without undertaking any calculations, the value of the product moment correlation coefficient between the variables x and y for each of Scatter Diagrams 1 and 2

(i) Scatter Diagram 1



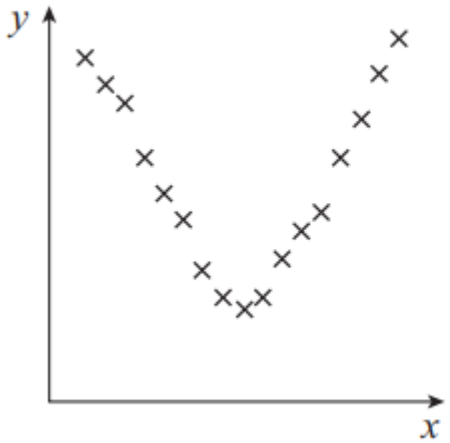
(ii) Scatter Diagram 2



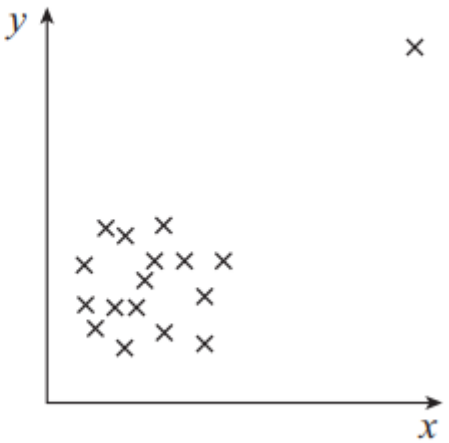
[2 marks]

For each of Scatter Diagrams 3 and 4, give a reason why a calculation of the product moment correlation coefficient would not be appropriate.

(i) Scatter Diagram 3



(ii) Scatter Diagram 4



[2 marks]