A Level Statistics
AQA Past Exam Questions

TOPIC: Probability Theory

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 **75** questions in this question paper. The total mark for this paper is ***229***

• 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_6

Twins Alec and Eric are members of the same local cricket club and play for the club's under 18 team.

The probability that Alec is selected to play in any particular game is 0.85 .

The probability that Eric is selected to play in any particular game is 0.60 .

The probability that both Alec and Eric are selected to play in any particular game is 0.55 .

a) By using a table, or otherwise:
   i. show that the probability that neither twin is selected for a particular game is 0.10
   ii. find the probability that at least one of the twins is selected for a particular game;
   iii. find the probability that exactly one of the twins is selected for a particular game.

(5 marks)

b) The probability that the twins' younger brother, Cedric, is selected for a particular game is:
   0.30 given that both of the twins have been selected;
   0.75 given that exactly one of the twins has been selected;
   0.40 given that neither of the twins has been selected.
   Calculate the probability that, for a particular game:
   i. all three brothers are selected;
   ii. at least two of the three brothers are selected.

(6 marks)

AQA_JAN_2013_5

Roger is an active retired lecturer. Each day after breakfast, he decides whether the weather for that day is going to be fine (F), dull (D) or wet (W).

He then decides on only one of four activities for the day: cycling (C), gardening (G), shopping (S) or relaxing (R).

His decisions from day to day may be assumed to be independent. The table shows Roger's probabilities for each combination of weather and activity.

Weather	**Fine (F)**	**Dull (D)**	**Wet (W)**
Activity Cycling (C)	0.30	0.10	0
Gardening (G)	0.25	0.05	0
Shopping (S)	0	0.10	0.05
Relaxing (R)	0	0.05	0.10

a) Find the probability that, on a particular day, Roger decided:
   i. that it was going to be fine and that he would go cycling;
   ii. on either gardening or shopping;
   iii. to go cycling, given that he had decided that it was going to be fine;
   iv. not to relax, given that he had decided that it was going to be dull;
   v. that it was going to be fine, given that he did not go cycling.

(9 marks)

b) Calculate the probability that, on a particular Saturday and Sunday, Roger decided that it was going to be fine and decided on the same activity for both days.

(3 marks)

AQA_JUNE_2012_4

A survey of the 640 properties on an estate was undertaken. Part of the information collected related to the number of bedrooms an
d the number of toilets in each property.
This information is shown in the table.

	Number of toilets				
Number of bedrooms	**1**	**2**	**3**	**4 or more**	**Total**
1	46	14	0	0	60
2	24	67	23	0	114
3	7	72	99	16	194
4	0	19	123	48	190
5 or more	0	0	11	71	82
Total	77	172	256	135	640

a) A property on the estate is selected at random. Find, giving your answer to three decimal places, the probability that the property has:

i. exactly 3 bedrooms;

(1 mark)

ii. at least 2 toilets;

(2 marks)

iii. exactly 3 bedrooms and at least 2 toilets;

(2 marks)

iv. at most 3 bedrooms, given that it has exactly 2 toilets.

(3 marks)

b) Use relevant answers from part (a) to show that the number of toilets is not independent of the number of bedrooms.

(2 marks)

c) Three properties are selected at random from those on the estate which have exactly 3 bedrooms. Calculate the probability that one property has 2 toilets, one has 3 toilets and the other has at least 4 toilets. Give your answer to three decimal places.

(4 marks)

AQA_JAN_2007_5

Dafydd, Eli and Fabio are members of an amateur cycling club that holds a time trial each Sunday during the summer. The independent probabilities that Dafydd, Eli and Fabio take part in any one of these trials are 0.6, 0.7 and 0.8 respectively.
Find the probability that, on a particular Sunday during the summer:

a) none of the three cyclists takes part;

(2 marks)

b) Fabio is the only one of the three cyclists to take part;

(2 marks)

c) exactly one of the three cyclists takes part;

(3 marks)

d) either one or two of the three cyclists take part.

(3 marks)

AQA_JUNE_2013_5

Alison is a member of a tenpin bowling club which meets at a bowling alley on Wednesday and Thursday evenings.

The probability that she bowls on a Wednesday evening is 0.90 . Independently, the probability that she bowls on a Thursday evening is 0.95 .

a) Calculate the probability that, during a particular week, Alison bowls on:

i. two evenings;

ii. exactly one evening.

(3 marks)

b) David, a friend of Alison, is a member of the same club.

The probability that he bowls on a Wednesday evening, given that Alison bowls on that evening, is 0.80 . The probability that he bowls on a Wednesday evening, given that Alison does not bowl on that evening, is 0.15 .

The probability that he bowls on a Thursday evening, given that Alison bowls on that evening, is 1 . The probability that he bowls on a Thursday evening, given that Alison does not bowl on that evening, is 0 . Calculate the probability that, during a particular week:

i. Alison and David bowl on a Wednesday evening;

(2 marks)

ii. Alison and David bowl on both evenings;

(2 marks)

iii. Alison, but not David, bowls on a Thursday evening;

(1 mark)

iv. neither bowls on either evening.

(3 marks)

AQA_JAN_2008_5

A health club has a number of facilities which include a gym and a sauna. Andrew and his wife, Heidi, visit the health club together on Tuesday evenings.

On any visit, Andrew uses either the gym or the sauna or both, but no other facilities. The probability that he uses the gym, PðGÞ, is 0.70 . The probability that he uses the sauna, PðSÞ, is 0.55 . The probability that he uses both the gym and the sauna is 0.25 .

a) Calculate the probability that, on a particular visit:

i) he does not use the gym;

(1 mark)

ii) he uses the gym but not the sauna;

(2 marks)

iii) he uses either the gym or the sauna but not both.

(2 marks)

b) Assuming that Andrew's decision on what facility to use is independent from visit to visit, calculate the probability that, during a month in which there are exactly four Tuesdays, he does not use the gym.

(2 marks)

c) The probability that Heidi uses the gym when Andrew uses the gym is 0.6 , but is only 0.1 when he does not use the gym. Calculate the probability that, on a particular visit, Heidi uses the gym.

(3 marks)

d) On any visit, Heidi uses exactly one of the club's facilities. The probability that she uses the sauna is 0.35 . Calculate the probability that, on a particular visit, she uses a facility other than the gym or the sauna.

(2 marks)

AQA_JAN_2009_4

Gary and his neighbour Larry work at the same place.

On any day when Gary travels to work, he uses one of three options: his car only, a bus only or both his car and a bus. The probability that he uses his car, either on its own or with a bus, is 0.6 . The probability that he uses both his car and a bus is 0.25 .

a) Calculate the probability that, on any particular day when Gary travels to work, he:

i) does not use his car;

(1 mark)

ii) uses his car only;

(2 marks)

iii) uses a bus.

(3 marks)

b) On any day, the probability that Larry travels to work with Gary is 0.9 when Gary uses his car only, is 0.7 when Gary uses both his car and a bus, and is 0.3 when Gary uses a bus only.

i) Calculate the probability that, on any particular day when Gary travels to work, Larry travels with him.

(4 marks)

ii) Assuming that option choices are independent from day to day, calculate, to three decimal places, the probability that, during any particular week (5 days) when Gary travels to work every day, Larry never travels with him.

(2 marks)

AQA_JAN_2010_4

Each school-day morning, three students, Rita, Said and Ting, travel independently from their homes to the same school by one of three methods: walk, cycle or bus. The table shows the probabilities of their independent daily choices.

	Walk	**Cycle**	**Bus**
Rita	0.65	0.10	0.25
Said	0.40	0.45	0.15
Ting	0.25	0.55	0.20

a) Calculate the probability that, on any given school-day morning:

i) all 3 students walk to school;

(2 marks)

ii) only Rita travels by bus to school;

(2 marks)

iii) at least 2 of the 3 students cycle to school.

(4 marks)

b) Ursula, a friend of Rita, never travels to school by bus. The probability that:
Ursula walks to school when Rita walks to school is 0.9 ;
Ursula cycles to school when Rita cycles to school is 0.7 .
Calculate the probability that, on any given school-day morning, Rita and Ursula travel to school by:

i) the same method;

(3 marks)

ii) different methods.

(1 mark)

AQA_JAN_2011_2

The number of MPs in the House of Commons was 645 at the beginning of August 2009. The genders of these MPs and the political parties to which they belonged are shown in the table.

	Political Party				
Gender	**Labour**	**Conservative**	**Liberal Democrat**	**Other**	**Total**
Male	255	175	54	35	519
Female	94	18	9	5	126
Total	349	193	63	40	645

a) One MP was selected at random for an interview. Calculate, to three decimal places, the probability that the MP was:

i. a male Conservative;

(1 mark)

ii. a male;

(1 mark)

iii. a Liberal Democrat;

(1 mark)

iv. Labour, given that the MP was female;

(2 marks)

v. male, given that the MP was not Labour.

(3 marks)

b) Two female MPs were selected at random for an enquiry. Calculate, to three decimal places, the probability that both MPs were Labour.

(2 marks)

c) Three MPs were selected at random for a committee. Calculate, to three decimal places, the probability that exactly one MP was Labour and exactly one MP was Conservative.

(4 marks)

AQA_JUNE_2007_2

The British and Irish Lions 2005 rugby squad contained 50 players. The nationalities and playing positions of these players are shown in the table.

Nationality

Playing English Welsh Scottish Irish

Forward 14 5 2 6 position Back 8726

a) A player was selected at random from the squad for a radio interview. Calculate the probability that the player was:

i. a Welsh back;

(1 mark)

ii. English;

(2 marks)

iii. not English;

(1 mark)

iv. Irish, given that the player was a back;

(2 marks)

v. a forward, given that the player was not Scottish.

(2 marks)

b) Four players were selected at random from the squad to visit a school. Calculate the probability that all four players were English.

(3 marks)

AQA_JUNE_2008_2

A basket in a stationery store contains a total of 400 marker and highlighter pens. Of the marker pens, some are permanent and the rest are non-permanent. The colours and types of pen are shown in the table.

	Colour			
Type	**Black**	**Blue**	**Red**	**Green**
Permanent marker	44	66	32	18
Non-permanent marker	36	53	21	10
Highlighter	0	41	37	42

A pen is selected at random from the basket. Calculate the probability that it is:

a) a blue pen;

(1 mark)

b) a marker pen;

(2 marks)

c) a blue pen or a marker pen;

(2 marks)

d) a green pen, given that it is a highlighter pen;

(2 marks)

e) a non-permanent marker pen, given that it is a red pen.

(2 marks)

AQA_JUNE_2009_1

A large bookcase contains two types of book: hardback and paperback. The number of books of each type in each of four subject categories is shown in the table.

	Subject category				
Type	**Crime**	**Romance**	**Science fiction**	**Thriller**	**Total**
Hardback	8	16	18	18	60
Paperback	16	40	14	30	100
Total	24	56	32	48	160

a) A book is selected at random from the bookcase.
Calculate the probability that the book is:

i. a paperback;

(1 mark)

ii. not science fiction;

(2 marks)

iii. science fiction or a hardback;

(2 marks)

iv. a thriller, given that it is a paperback.

(2 marks)

b) Three books are selected at random, without replacement, from the bookcase. Calculate, to three decimal places, the probability that one is crime, one is romance and one is science fiction.

(4 marks)

AQA_JUNE_2011_5

a) Emma visits her local supermarket every Thursday to do her weekly shopping.
The event that she buys orange juice is denoted by J, and the event that she buys bottled water is denoted by W.

At each visit, Emma may buy neither, or one, or both of these items.

i. Complete the table of probabilities, printed below, for these events, where J ' and W ' denote the events 'not J' and 'not W' respectively.

(3 marks)

	J	**J'**	**Total**
W			0.65
W'	0.15		
Total		0.30	1.00

ii. Hence, or otherwise, find the probability that, on any given Thursday, Emma buys either orange juice or bottled water but not both.

(2 marks)

iii. Show that:

(A) the events J and W are not mutually exclusive;
(B) the events J and W are not independent.

(3 marks)

b) Rhys visits the supermarket every Saturday to do his weekly shopping. Items that he may buy are milk, cheese and yogurt.

The probability, P(M), that he buys milk on any given Saturday is 0.85
The probability, P(C), that he buys cheese on any given Saturday is 0.60
The probability, P(Y), that he buys yogurt on any given Saturday is 0.55
The events M, C and Y may be assumed to be independent.

Calculate the probability that, on any given Saturday, Rhys buys:

i. none of the 3 items;

(2 marks)

ii. exactly 2 of the 3 items.

(3 marks)

AQA_JUNE_2017_4

a) The events A and B are such that P(A) = 0.45 and P(B) = 0.20
Write down the value of:

i. P(A ∪ B) if A and B are mutually exclusive;
ii. P(A ∩ B) if A and B are independent;
iii. P(A ∪ B) if A and B are independent.

[3 marks]

b) Every weekday morning, three mechanics, Clare, Dinesh and Elroy, arrive independently at the garage where they all work.
On any weekday morning, the probability that Clare arrives late for work is 0.05 , the probability that Dinesh arrives late for work is 0.09 , and the probability that Elroy arrives late for work is 0.12
For these three mechanics, determine the probability that, on a particular weekday morning:

i. none are late for work;
ii. only Elroy is late for work;
iii. exactly one is late for work;
iv. two or more are late for work.

[7 marks]

AQA_JUNE_2015_4

a) Chris shops at his local store on his way to and from work every Friday.
The event that he buys a morning newspaper is denoted by M, and the event that he buys an evening newspaper is denoted by E.
On any one Friday, Chris may buy neither, exactly one or both of these newspapers.

i. Complete the table of probabilities, printed on the opposite page, where M' and E' denote the events 'not M' and 'not E' respectively.

[3 marks]

ii. Hence, or otherwise, find the probability that, on any given Friday, Chris buys exactly one newspaper.

[2 marks]

iii. Give a numerical justification for the following statement. 'The events M and E are not mutually exclusive.'

[2 marks]

b) The event that Chris buys a morning newspaper on Saturday is denoted by S, and the event that he buys a morning newspaper on the following day, Sunday, is denoted by T.
The event that he buys a morning newspaper on both Saturday and Sunday is denoted by $S \cdot T$.
Each combination of the events S and T is independent of any combination of the events M and E. However, the events S and T are not independent, with

$$P(S) = 0.85,\ P(T \mid S) = 0.20 \text{ and } P(T \mid S') = 0.75$$

Find the probability that, on a particular Friday, Saturday and Sunday, Chris buys:

i. all four newspapers;

[2 marks]

ii. none of the four newspapers.

[2 marks]

c)

i. State, as briefly as possible, in the context of the question, the event that is denoted by $M \cap E' \cap S \cap T'$

[2 marks]

ii. Calculate the value of $P(M \cap E' \cap S \cap T')$

[2 marks]

AQA_JUNE_2015_4

Alf and Mabel are members of a bowls club and sometimes attend the club's social events.

The probability, P(A), that Alf attends a social event is 0.70
The probability, P(M), that Mabel attends a social event is 0.55
The probability, P(A ∩ M), that both Alf and Mabel attend the same social event is 0.45

a) Find the probability that:
   i. either Alf or Mabel or both attend a particular social event;
   ii. Neither Alf or Mabel but not both attend a particular social event.

[3 marks]

   iii. Give a numerical justification for the following statement. "Events A and M are not independent."

[2 marks]

   iv. Ben and Nora are also members of the bowls club and sometimes attend the club's social events.

   The probability, P(B), that Ben attends a social event is 0.85
   The probability, P(N), that Nora attends a social event is 0.65
   The attendance of each of Ben and Nora at a social event is independent of the attendance of all other members.

   Find the probability that:
   i. all four named members attend a particular social event;

[2 marks]

   ii. none of the four named members attend a particular social event.

[3 marks]

AQA_JUNE_2016_4

A cafe´ serves four types of bread roll, and each roll contains one of four fillings.
The combinations offered, together with the number of each combination chosen by 400 customers who purchased rolls, are shown in the table.

	Filling				
Type of bread roll	**Ham**	**Chicken**	**Egg**	**Cheese**	**Total**
Soft white	56	45	32	17	150
Crusty white	50	25	21	14	110
Soft brown	30	24	17	9	80
Crusty brown	24	26	10	0	60
Total	160	120	80	40	400

a) A customer is selected at random from these 400 customers. Calculate the probability that this customer chose:
   i. a crusty white roll;
   ii. a soft white roll with ham filling;
   iii. a brown roll with either ham or chicken filling;
   iv. a soft white roll, given that the customer chose chicken filling;
   v. either egg or cheese filling, given that the customer chose a white roll.

[9 marks]

b) You may assume that the 400 customers represent a random sample of all customers purchasing rolls at this cafe´.
   Four customers, not included in the above 400 customers, were selected at random from those customers purchasing rolls at the cafe´.
   Estimate, to five decimal places, the probability that two of them chose white rolls with chicken filling and two of them chose brown rolls with ham filling.

[5 marks]