A Level Statistics
AQA Past Exam Questions
SOLUTIONS
TOPIC: Discrete Random Variables

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 **17** questions in this question paper. The total mark for this paper is ***158***

• 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_7

(a)	$p = 1 - (\text{sum of Ps}) = 0.12$ p is probability that Angus has to do all the work alone	B1 E1		 Anything conveying this concept
			2	
(b)	$E(X) = 0\times p + 1\times0.15 + 2\times0.2 + 3\times0.21 + 4\times0.18 + 5\times0.14 = 2.6$ $E(X^2) = 0^2\times p + 1^2\times0.15 + 2^2\times0.2 + 3^2\times0.21 + 4^2\times0.18 + 5^2\times0.14\ (= 9.22)$ $\text{Var}(X) = \text{'9.22'} - \text{'2.6'}^2\ (= 2.46)$ $\text{s.d} = \sqrt{2.46} = 1.57$	M1 A1 M1 m1 A1		 Or B2 for answer alone Complete method incl – $E(X)^2$ Or similar totally correct working AG SC: $E(X^2) = 9.22$ with no explanation followed by $\text{Var}(X) = 9.22 - 2.6^2$, $\text{s.d} = \sqrt{2.46} = 1.57$ earns B2 SC: $\text{s.d.} = \sqrt{(9.22 - 2.6^2)}$ with no explanation for 9.22 earns B1
			5	

AQA_JAN_2012_3

3(a)(i)	$E(X) = 0\times0.1 + 1\times0.15 + 2\times0.25 + 3\times0.35 + 4\times0.15 = 2.3$	M1		Must see this working for this M1
	$E(X^2) = 0^2\times0.1 + 1^2\times0.15 + 2^2\times0.25 + 3^2\times0.35 + 4^2\times0.15\ (= 6.7)$	M1		These 3 marks are to be given if CAO seen from calculator work.
	$\text{Var}(X) = \text{"6.7"} - 2.3^2 = 1.41$	m1		
	s.d. = 1.19	A1	4	AWRT 1.19
(ii)	$2.3\times24 - 1.7\times16$ = (£)28	M1 A1	2	Or by direct calculation of profit from probability distribution. AG
(b)(i)	0.5	B1	1	
(ii)	$E(X) = 0\times0.1 + 1\times0.15 + 2\times0.25 + 3\times0.5 = 2.15$	B1		
	$2.15\times24 - 0.85\times16$	M1		
	= (£)38	A1	3	
(iii)	More profit	E1	1	
(iv)	Might lose/disappoint customers who request lobster but cannot have it.	E1	1	OE Must refer to losing customers not profit
	Total		**12**	

AQA_JAN_2013_5

5 (a)	Mean = $1 \times 0.03 + 2 \times 0.12 +$ etc. $= 3.51$	M1		
	$E(X^2) = 1 \times 0.03 + 4 \times 0.12 + \ldots$	M1		
	$Var(X) = E(X^2) - E(X)^2$	m1		**Applied** in this case
	$=1.0299$	A1		AWRT 1.03
			4	
(b)(i)	0.51	B1		
			1	

AQA_JUNE_2012_1

1 (a)	0.2, 0.3	B1, B1		
			2	
(b)	$E(X) = 0 \times 0.2 + 1 \times 0.3 + 3 \times 0.5$	M1		
	$= 1.8$	A1		CAO nms B2
	$E(X^2) = 0^2 \times 0.2 + 1^2 \times 0.3 + 3^2 \times 0.5$	M1		
	$Var(X) = E(X^2) - E(X)^2 = 4.8 - 1.8^2$	M1		Must be applied. Must be identified as $Var(X)$
	s.d $= \sqrt{1.56} = 1.25$	A1		AWRT nms B3
			5	
(c)	P(points > 3.05) = 0	B1F		If *their* $E(X)$ + s.d. < 3 accept 0.5
			1	
	Total		**8**	

AQA_JAN_2008_5

5(a)(i)	$E(X) = 0{\times}0.005 + 1{\times}0.015 + 2{\times}0.08 +$ $3{\times}0.15 + 4{\times}0.75 = 3.625$	M1		method $E(X)$
(ii)	$E(X^2) = 13.685$	M1		method $E(X^2)$
	$V(X) = 13.685 - 3.625^2$	m1		method for variance
	$= 0.544375$			
	s.d. $= \sqrt{0.544375} = 0.738$	m1		method for s.d.
		A1	5	0.738 (0.737 ~ 0.739)

AQA_JUNE_2013_3

3(a)(i)	$E(X) = 10 \times 0.18 + 20 \times 0.44$ etc $= 59.1$	M1 A1	2	Or B2 for answer
(ii)	$E(X^2) = 10^2 \times 0.18 + 20^2 \times 0.44$ etc	B1		Showing what E(X^2) comes from
	$= 8119. \text{Var}(X) = E(X^2) - E(X)^2$ = '8119' – '59.1^2'	M1		**Complete** method. Dep on B1
	= 4626.19 So s.d. = √ 4626.19 = 68.0	A1	3	AG Condone 68
(iii)	0.08 + 0.17 = 0.25 or 0.18 + 0.44 + 0.13 = 0.75	B1		
	$1 - 0.75^3$ or use of B(3, 0.25)	M1		Allow for sight of 0.4219
	= 0.578	A1	3	AWRT
(b)(i)	Increase	B1		
(ii)	Increase	B1	2	
(c)	Probability for 0 adds nothing extra to E(X), while other probabilities fall reducing E(X) **Or** Total withdrawn does not increase, but number of customers does **Or** £0 is below the original mean and adding extra values below the original mean will reduce the mean	E2	2	Some statement conveying correct concept. E1 for partial explanation
	Total		**12**	

AQA_JUNE_2014_1

1(a) (i)	0.57	B1	**1**	CAO
(ii)	360 × 0.57, 0.32 and 0.11 = 205.2°, 115.2°, 39.6°	M1 A1	**2**	At least one Any two. CAO
(b)	Mean = 20 × 0.57 + 50 × 0.32 + 210 × 0.11 = 50.5 $20^2 \times 0.57 + 50^2 \times 0.32 + 210^2 \times 0.11 - 50.50^2$ = 3328.75 s.d = £57.70	M1 A1 M1 A1	**4**	 AG 3328.75 seen unsupported earns M1 AWFW £57.60 to £57.70
(c)(i)	Mean = 10 × 0.57 + 50 × 0.32 + 210 × 0.11 = £44.80	B1		Or £50.50 – £5.70
(ii)	1.2 × 90 × 44.80 – (50.5 × 90) = £293.40	M1 A1	**3**	 Accept £293

AQA_JUNE_2016_2

(a)(i)	$0.21 + 0.10 + 0.20$ $= 0.51$ $(= 51\% = {}^{51}/_{100})$	B1	**1**	Answer in any of these three forms
(ii)	$0.12^2 + 0.19^2 + 0.18^2 + 0.21^2 + 0.1^2 + 0.2^2$ $= 0.177$ $(= 17.7\% = {}^{177}/_{1000})$	M1 A1	**2**	Allow 1 slip CAO. Answer in any of these three forms
(b)(i)	New table 0.50 | 1 | 1.50 | 2 | 3 | 5 0.12 | 0.19 | 0.18 | 0.21 | 0.10 | 0.20	B1		May be implied by next line or correct answer
	Mean $= 0.50 \times 0.12 + 1 \times 0.19 \ldots + 5 \times 0.20$ $= 2.24$	M1 A1		Correct method based on an attempt at new table. CAO
	Special Cases: No working but correct answer B3 Wrong working but correct answer B2			
	$0.50^2 \times 0.12 + 1^2 \times 0.19 \ldots + 5^2 \times 0.20 - \text{'}2.24\text{'}^2$ $= 7.365 - \text{'}2.24\text{'}^2$ $= 2.3474$ and $\sqrt{2.3474} = 1.53$	M1 A1	**5**	Complete method (their 2.24) AG
(ii)	$\text{'}2.24\text{'} \pm 1.53 = 0.71, 3.77$ $0.19 + 0.18 + 0.21 + 0.10 = 0.68$	M1 A1	**2**	Their mean – both values required CAO. Or B2 for answer alone
			10	

AQA_JUNE_2018_1

Q	Solution	Marks	Total	Comments
1 (a)	0.4, 40% or ${}^{2}/_{5}$	B1	**1**	Any form but not simply 40
(b)	0.6×0.25	M1		If unsupported answer 0.15 is given allow this M1
	$\times 2 = 0.3$ (or 30% or ${}^{3}/_{10}$)	A1	**2**	Any equivalent form
(c)	Mean $= 1 \times 0.24 + 2 \times 0.36 \ldots + 5 \times 0.03$ $= 2.44$	M1 A1		CAO. Unsupported 2.44 scores B2
	$1^2 \times 0.24 + 2^2 \times 0.36 \ldots + 5^2 \times 0.03 - 2.44^2$ $= 0.24 + 1.44 + 1.35 + 3.52 + 0.75 - 2.44^2$	M1		**Complete** method (their 2.44) Products or results of products
	$= 7.3 - 2.44^2 = 1.3464$ and $\sqrt{(7.3 - 2.44^2)} = \sqrt{1.3464}$ (= 1.16)	A1 A1	**5**	Either of these AG
(d)	$E(C) = 68 + 24 \times 1.44 = £102.56$	B1		102.56 or 102.6 or 103
	$\sigma_c = 24 \times 1.16 = 27.8(4)$ May use new table	B1	**2**	27.8, or AWFW 27.80 to 27.90
		Total	**10**	

AQA_JUNE_2017_4

Q4	Solution	Mark	Total	Comment
(a)(i)	0.41, 41% or $^{41}/_{100}$	B1	1	Not simply 41
(ii)	Probability of being engraved = 1 – 0.26 (= 0.74)	B1		Stated or used
	$(1 - 0.26)^2 \times 0.26$ (= 0.142376) Or stated use of B(3, 0.74)	M1		PI by answer
	× 3 = 0.427 (to 3 sf)	A1	3	AWRT
(iii)	Mean = 0 × 0.26 + 1 × 0.18 … + 8 × 0.02 = 2.75	M1 A1		PI CAO Do not ignore rounding to 3
	Var = $0^2 \times 0.26 + 1^2 \times 0.18 \ldots + 8^2 \times 0.02$ – ('2.75')^2	M1		At least two of the products shown and subtracting their '2.75^2'
	= 13.37 – ('2.75')^2 = 5.8075 (= 5.81 to 3 sf)	A1	4	Must show something with at least 3 dp AWRT 5.81 (given)
(b)(i)	5 + 0.40 × "2.75"	M1		Or use of a correct new table. Their mean
	= (£)6.10	A1	2	CAO. Condone 610 not labelled
(ii)	**Either** 5.8075 or 5.81 × 0.4^2 then square rooted to give £0.96 or 96p (to the nearest penny)	M1 A1		CAO Ignore lack of units
	Or 0.4 ×√(5.8075 or 5.81) = £0.96 or 96p (to the nearest penny)	(M1) (A1)		CAO Ignore lack of units
	Or use of a correct new table s.d = £0.96 or 96p (to the nearest penny)	(M1) (A1)	2	Complete method including √ CAO
	Total		12	

AQA_JAN_2007_3

3(a)	$E(X) = 225 \times 0.56 + 145 \times 0.32 +$ $249 \times 0.09 + 253 \times 0.03 = 202.4$	M1 A1	2	method correct expression - **AG**
(b)	s.d. = 40.2 $E(X^2) = 225^2 \times 0.56 + 145^2 \times 0.32 +$ $249^2 \times 0.09 + 253^2 \times 0.03 = 42578.36$ $V(X) = 42578.36 - 202.4^2 = 1612.6$ s.d. = 40.2	 M1 m1 A1	 3	B3 40.2 (40.1 ~ 40.3) or method for $E(X^2)$ method for $V(X)$ 40.2 (40.1 ~ 40.3)
(c)	mean 225 s.d. 0	B1 B1	2	225 cao 0 cao
(d)	more choice may attract more customers etc	E1	1	any sensible reason
	Total		**8**	

AQA_JAN_2011_1

1(a)	$E(X) = 99\times0.5+ 125\times0.3 +144\times0.2$ $= 115.8$ $E(X^2) = 99^2\times0.5 + 125^2\times0.3+144^2\times0.2 =$ 13735.2 $V(X) = 13735.2 - 115.8^2 = 325.56$ s.d. $= \sqrt{325.56} = 18.04$	M1 A1 M1 A1	 4	B2 115.8 (115.5 ~ 116) or M1 A1 B2 18.04 (18 ~ 18.1) or M1A1
(b)(i)	$E(Y) = 79\times0.25 + 99\times0.375 +$ $125\times0.225 + 144\times0.15 =$ 106.6	M1 A1	 2	M1 method A1 107 ag
(ii)	$106.6\times1.2 = 127.92 > 115.8$ hence increase in customers will mean increase in the total takings on tea bags despite the lower mean.	M1 m1 A1	 3	M1 Any calculation which could be helpful in answering the question m1 attempt at a valid comparison A1 correct conclusion based on correct calculations — allow use of 107 for $E(Y)$
(c)	Extra customers in shop for cheap teabags may make additional purchases.	E1	1	E1 Any sensible point
	Total		**10**	

AQA_JUNE_2007_3

3(a)	$E(X) = 0\times0.32+1\times0.25+2\times0.19+$ $3\times0.12+4\times0.09+5\times0.03$	M1		method for E(X)
	$= 1.5$	A1		1.5 CAO
	$E(X^2) = 0^2\times0.32+1^2\times0.25+$ $2^2\times0.19+3^2\times0.12+$ $4^2\times0.09+5^2\times0.03$	M1		method for E(X^2) – may be implied
	$= 4.28$			
	$\text{Var}(X) = 4.28-1.5^2 = 2.03$	m1		method for s.d.; allow for variance = 2.03
	s.d. $=\sqrt{2.03}$			
	$= 1.42$	A1	5	1.42(1.41~1.43)
(b)(i)	s.d. $=\sqrt{2.2}$	M1		method
	$=1.48$	A1	2	1.48(1.48~1.49)
(b)(ii)	more houses in Cheadleville are advertised in the Clarion than in the Sentinel. The week to week variability is similar	E1√		Clarion higher average
		E1	2	variability similar
(c)	choose Clarion – since more houses in Cheadleville advertised on average	B1√		Clarion
		B1	2	higher mean
	Total		**11**	

AQA_JUNE_2008_2

2(a)(i)	$E(X) = 120\times0.22+80\times0.28+$ $75\times0.12+30\times0.38 = 69.2$	M1		Method for E(X); AG
(ii)	$E(X^2) = 120^2\times0.22+80^2\times0.28+$ $75^2\times0.12+30^2\times0.38 = 5977$	M1		Method for E(X^2) – may be implied
	$V(X) = 5977 - 69.2^2 = 1188.36$	m1		Method for variance
		m1		Method for s.d. – dependent on previous 3 marks
	s.d. = £34.50	A1	5	34.50 (34.45 ~ 35.5) – ignore units
(b)	$\frac{69.2\times400}{120} = 230.7$	M1		
	231 full members needed	A1	2	CAO
(c)	No junior members bad for future of club. May be less than 231 applications for full membership.	E1	1	Any sensible reason
	Total		**8**	

AQA_JUNE_2009_2

2(a)	$\mu = 101.6$	B2		CAO (allow 102) (or $E(X) = 50 \times 0.40 + 95 \times 0.16 + 135 \times 0.24 + 170 \times 0.20 = 101.6$ M1A1)
	$\sigma = 47.7$	B2	4	47.69 ~ 47.71 (or $E(X^2) = 50^2 \times 0.40 + 95^2 \times 0.16 + 135^2 \times 0.24 + 170^2 \times 0.20 = 12598$ $V(X) = 12598 - 101.6^2 = 2275.44$ s.d. $= \sqrt{2275.44} = 47.7$ M1A1)
(b)(i)	$E(X) = 95 \times 0.45 + 135 \times 0.30 + 170 \times 0.25 = 125.75$	M1		
	= 126 to 3sf	A1	2	CAO; AG
(ii)	Will lose 20% of customers $0.8 \times 125.75 = 100.6$	M1		Any relevant calculation attempted
	… which is less than 101.6.	m1		Valid comparison - their figures
	Hence, if estimate is correct, she will take less money.	A1	3	Correct conclusion based on correct working or lose $0.2 \times 50 = 10$; gain $0.2 \times (95 - 50) = 9$ or $100 \times 101.6 = 101.60$ $(100 - 120) \times 125.75 = 100.60$
	Total		**9**	

AQA_JUNE_2010_1

1(a)	$E(X) = 40 \times 0.37 + 70 \times 0.18 + 100 \times 0.14$	M1		M1 method for E(X)
(i)	$+140 \times 0.12 + 190 \times 0.19$ $= 94.3$			
(ii)	$E(X^2) = 40^2 \times 0.37 + 70^2 \times 0.18 + 100^2 0.\times 14 + 140^2 \times 0.12 + 190^2 \times 0.19$ $= 12085$	M1		M1 method for $E(X^2)$ ag
(iii)	$V(X) = 12085 - 94.3^2 = 3192.51$ s.d. $= \sqrt{3192.51} = 56.5$	M1 m1A1	5	M1 method for variance m1 method for s.d. A1 56.5 (56.4 – 56.6)
(b)(i)	0.31	B1		B1 0.31 CAO
(ii)	0	B1	2	B1 0
(c)	Smaller, 0 is less than the mean of fare-paying passengers.	B1 B1	2	B1 smaller B1 $0 < 94.3$ or equivalent
	Total		**9**	

AQA_JUNE_2011_2

2(a)(i)	$E(X) = 100 \times 0.22 + 200 \times 0.31 + 300 \times 0.21 + 400 \times 0.12 + 600 \times 0.14 = 279$	M1 A1		M1 method A1 279 CAO AG
(ii)	$E(X^2) = 100^2 \times 0.22 + 200^2 \times 0.31 + 300^2 \times 0.21 + 400^2 \times 0.12 + 600^2 \times 0.14 = 103100$			
	$V(X) = 103100 - 279^2 = 25259$	M1		
	s.d. $= \sqrt{25259} = 158.9$	A1	4	B2 159 (158.5 ~ 159.5) or M1A1 SC: allow B1 for variance = 25259
(b)	Standard deviation would increase as distribution would be more spread out	B1 E1	2	B1 increase E1 reason
(c)	Standard deviation would be less than for X. Nearly all cars have parked for free so there is little variability in the distribution.	B1 E1	2	B1 less than X E1 reason
	Total		**8**	