Paper Reference(s)

6684/01

Edexcel GCE

Statistics S2

Advanced Level

Thursday 24 May 2012 – Morning

Time: 1 hour 30 minutes

Materials required for examination
Mathematical Formulae (Pink)

Items included with question papers
Nil

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Statistics S2), the paper reference (6684), your surname, other name and signature.
Values from the statistical tables should be quoted in full. When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has 8 questions.
The total mark for this paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

1. A manufacturer produces sweets of length L mm where L has a continuous unifrom distribution with range [15, 30].

(*a*) Find the probability that a randomly selected sweet has length greater than 24 mm.

(2)

These sweets are randomly packed in bags of 20 sweets.

(*b*) Find the probability that a randomly selected bag will contain at least 8 sweets with length greater than 24 mm.

(3)

(*c*) Find the probability that 2 randomly selected bags will both contain at least 8 sweets with length greater than 24 mm.

(2)

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2. A test statistic has a distribution B(25, p).

Given that

$$H_0 : p = 0.5, \quad H_1 : p \neq 0.5,$$

(*a*) find the critical region for the test statistic such that the probability in each tail is as close as possible to 2.5%.

(3)

(*b*) State the probability of incorrectly rejecting H_0 using this critical region.

(2)

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3. (*a*) Write down the two conditions needed to approximate the binomial distribution by the Poisson distribution.

(2)

A machine which manufactures bolts is known to produce 3% defective bolts. The machine breaks down and a new machine is installed. A random sample of 200 bolts is taken from those produced by the new machine and 12 bolts are defective.

(*d*) Using a suitable approximation, test at the 5% level of significance whether or not the proportion of defective bolts is higher with the new machine than with the old machine. State your hypotheses clearly.

(7)

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4. The number of houses sold by an estate agent follows a Poisson distribution, with a mean of 2 per week.

(*a*) Find the probability that in the next four weeks the estate agent sells

(i) exactly 3 houses,

(ii) more than 5 houses.

(5)

The estate agent monitors sales in periods of 4 weeks.

(*b*) Find the probability that in the next twelve of those 4 week periods there are exactly nine periods in which more than 5 houses are sold.

(3)

The estate agent will receive a bonus if he sells more than 25 houses in the next 10 weeks.

(*c*) Use a suitable approximation to estimate the probability that the estate agent receives a bonus.

(6)

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5. The queuing time, X minutes, of a customer at a till of a supermarket has probability density function

$$f(x) = \begin{cases} \frac{3}{32}x(k-x) & 0 \le x \le k, \\ 0 & \text{otherwise.} \end{cases}$$

(*a*) Show that the value of k is 4.

(4)

(*b*) Write down the value of E(X).

(1)

(*c*) Calculate Var (X).

(4)

(*d*) Find the probability that a randomly chosen customer's queuing time will differ from the mean by at least half a minute.

(3)

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6. A bag contains a large number of balls.

65% are numbered 1

35% are numbered 2

A random sample of 3 balls is taken from the bag.

Find the sampling distribution for the range of the numbers on the 3 selected balls.

(6)

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7. The continuous random variable X has probability density function f(x) given by

$$f(x) = \begin{cases} \frac{x^2}{45} & 0 \le x \le 3, \\ \frac{1}{5} & 3 < x < 4, \\ \frac{1}{3} - \frac{x}{30} & 4 \le x \le 10, \\ 0 & \text{otherwise.} \end{cases}$$

(a) Sketch f(x) for $0 \le x \le 10$.

(4)

(b) Find the cumulative distribution function F(x) for all values of x.

(8)

(c) Find P($X \le 8$).

(2)

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8. In a large restaurant an average of 3 out of every 5 customers ask for water with their meal.

A random sample of 10 customers is selected.

(*a*) Find the probability that

(i) exactly 6 ask for water with their meal,

(ii) less than 9 ask for water with their meal.

(5)

A second random sample of 50 customers is selected.

(*b*) Find the smallest value of n such that

$$\mathbf{P}(X < n) \ge 0.9,$$

where the random variable X represents the number of these customers who ask for water.

(3)

TOTAL FOR PAPER: 75 MARKS

END

Summer 2012
6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
1(a)	P(L>24) = $\frac{1}{15}\times 6$	M1
	= $\frac{2}{5}$ or 0.4 oe	A1
		(2)
(b)	Let X represent the number of sweets with $L > 24$	
	X~B(20, 0.4)	M1
	P($X \geq 8$) = 1 – P($X \leq 7$)	M1dep
	= 1 – 0.4159	
	= 0.5841 awrt 0.584	A1
		(3)
(c)	P(both $X \geq 8$) = $(0.5841)^2$	M1
	= 0.341…	A1 ft
		(2)
		Total 7

notes

1(a) M1 $\frac{1}{15}\times$(6 or 5.5 or 6.5 or (30 – 24)) or 1 - $\frac{1}{15}$ ((24 – 15) or (23.5 – 15) or (24.5 – 15))

(b) M1 using B(20, "their (a))

M1 dependent on 1st M1. Writing or use of 1 – P($X \leq 7$)

NB Use of normal/normal approximation/ Poisson/uniform gets M0 M0 A0

(c) M1 (their(b))^2 or $(0.58)^2$ or $(0.5841)^2$ or $(0.584)^2$

A1ft –either awrt 0.34 or follow through their answer to part (b) must be to 2sf or better.

Note you will have to check this.

Question Number	Scheme	Marks
2.(a)	$X \sim B(25,0.5)$ may be implied by calculations in part a or b	M1
	$P(X \leq 7) = 0.0216$	
	$P(X \geq 18) = 0.0216$	
	CR $X \leq 7; \cup X \geq 18$	A1,A1 (3)
(b)	P(rejecting H_0) = 0.0216 + 0.0216	M1
	= 0.0432 awrt 0.0432/0.0433	A1 (2)
		Total 5

Notes

2(a) M1 - Using B(25,0.5) – may be implied by a correct critical region or by calculations in part a or b
Note Just seeing either $P(X \leq 7)$ or $P(X \geq 18)$ scores M1 A0 A0.
You may need to check their probabilities in the tables for values other than 7 or 18.
1st A1 – also allow $X < 8$ or $[0,7]$ or $0 \leq X \leq 7$ or $0 \leq X < 8$ oe e.g. [0, 8) or a full list
DO NOT allow CRs given as $P(X \leq 7)$ or $7 - 0$ for the A mark.
2nd A1 – also allow $X > 17$ or $[18,25]$ or $18 \leq X \leq 25$ or $17 < X \leq 25$ oe e.g. (17, 25] or a full list
DO NOT allow CRs given as $P(X \geq 18)$ or 18 - 25 for the A mark.
SC $7 \geq X \geq 18$ gains M1 A1 A0.

(b) M1 – adding their two critical regions' probabilities together or may be awarded for awrt 0.0432
If they add their critical regions' probabilities and then go on and get a different probability as their answer then it is M0A0
e.g. 0.0216 + 0.0216 = 0.0432 then 0.05 – 0.0432 = 0.0068 gets M0 A0
e.g. 0.0216 + 0.0216 = 0.0432 < 0.05 reject H_0 gets M1 A1
e.g. 0.0216 + 0.0216 = 0.0432 so probability of rejecting H_0 is 1 – 0.0432 = 0.9568 gets M0 A0

Question Number	Scheme	Marks
3(a)	n – large/high/big/ n >50	B1
	p – small/close to 0 / p < 0.2	B1
		(2)
(b)	$H_0 : p = 0.03$ $H_1 : p > 0.03$	B1,B1
	Po(6)	B1
	$P(X \geq 12) = 1 - P(X \leq 11)$ or $P(X \leq 10) = 0.9574$	M1
	$= 1 - 0.9799$ $P(X \geq 11) = 0.0426$	
	$= 0.0201$ CR $X \geq 11$	A1
	$(0.0201 < 0.05)$	
	Reject H_0 or Significant or 12 lies in the Critical region.	M1 dep.
	There is evidence that the proportion of defective bolts has increased.	A1 ft
		(7)
		Total 9

(b) Notes

1st B1 for $H_0 : p = 0.03$

2nd B1 for $H_1 : p > 0.03$

SC If both hypotheses are correct but a different letter to p is used they get B1 B0

Also allow B1 B0 for $H_0 : \lambda = 6$ and $H_1 : \lambda > 6$

B1 writing or using Po(6)

<u>One tail</u>

1st M1 for writing or using 1 - $P(X \leq 11)$ or giving $P(X \leq 10) = 0.9574$ or giving $P(X \geq 11) = 0.0426$. May be implied by correct CR or probability = 0.0201

1st A1 for 0.0201 or CR $X \geq 11$/ $X > 10$. **NB** $P(X \leq 11) = 0.9799$ on its own scores M1A1

2nd M1 dependent on the 1st M1 being awarded. For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "significant" and "accept H_0". **Ignore comparisons**.

2nd A1 ft for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.05 < p < 0.95$	$p < 0.05$ or $p > 0.95$
2nd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>not increased/is not higher/oe</u>**	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>increased/is higher/oe</u>**

<u>Two tail</u>

1st M1 for writing or using 1 - $P(X \leq 11)$ or giving $P(X \geq 12) = 0.0201$ or giving $P(X \leq 11) = 0.9799$. May be implied by correct CR or probability = 0.0201

1st A1 for 0.0201 or CR $X \geq 12$/ $X > 11$. **NB** $P(X \leq 11) = 0.9799$ on its own scores M1A1

2nd M1 dependent on the 1st M1 being awarded. For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "significant" and "accept H_0". **Ignore comparisons**.

2nd A1 ft for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.025 < p < 0.975$	$p < 0.025$ or $p > 0.975$
2nd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>not increased/is not higher/oe</u>**	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>increased/is higher/oe</u>**

Use of N(6,5.82) May get B1 B1 B0 M1 (must use 11.5)A0 M1dep A1 ft

Question Number	Scheme		Marks
4(a)	Let X be the random variable the number of houses sold.		
	$X \sim$Po(8)		B1
(i)	$P(X \leq 3) - P(X \leq 2) = 0.0424 - 0.0138$ or $\frac{e^{-8}8^3}{3!}$		M1
	$= 0.0286$	awrt 0.0286	A1
(ii)	$P(X > 5) = 1 - P(X \leq 5)$		M1
	$= 1 - 0.1912$		
	$= 0.8088$	awrt 0.809	A1
			(5)
(b)	Let Y be the random variable = the number of periods where more than 5 houses are sold		
	$Y \sim$ B(12,0.8088)		M1
	$P(Y = 9) = (0.8088)^9(1 - 0.8088)^3\frac{12!}{9!3!}$		M1
	$= 0.228$	awrt 0.228	A1
			(3)
(c)	N(20,20)		M1A1
	$P(X > 25) = 1 - P\left(Z \leq \frac{25.5 - 20}{\sqrt{20}}\right)$		M1,M1,A1
	$= 1 - P(Z \leq 1.23)$		
	$= 1 - 0.8907$		
	$= 0.1093 / 0.1094$	awrt 0.109	A1
			(6)
			Total 14

Notes

(a) 1st B1 for writing or using Po(8) in either (i) or (ii)

(i) M1 writing or using $P(X \leq 3) - P(X \leq 2)$ or $\frac{e^{-8}8^3}{3!}$

(ii) M1 writing or using $1 - P(X \leq 5)$

(b) M1 writing or attempting to use B(12,their (a(ii))) NB ft their a(ii) to at least 2sf

M1 $\frac{12!}{9!3!}$ (a(ii))^9(1- a(ii))^3 allow $^{12}C_3$ or $^{12}C_9$ or 220 instead of $\frac{12!}{9!3!}$ NB ft their a(ii) to at least 1sf but an expression must be seen (No use of tables)

(c) 1st M1 for writing or using a normal approximation

1st A1 for correct mean and sd (may be given if correct in standardisation formula)

2nd M1 Standardising using their mean and their sd and using [24.5, 25, 25.5, 26 or 26.5] and for finding correct area by doing 1 – P(Z≤ "their 1.23")

NB if they have not written down a mean and sd then they need to be correct in the standardisation to gain this mark.

3rd M1 for attempting a continuity correction (26± 0.5)

2nd A1 for $\pm\frac{25.5 - 20}{\sqrt{20}}$ or ± awrt 1.2 or better.

SC using P(X< 26.5/25.5) – P(X<25.5/24.5) can get M1A1 M0M1A0A0

Question Number	Scheme	Marks
5(a)	$\int_0^k \frac{3}{32}x(k-x)=1$	M1
	$\frac{3}{32}\left[\frac{kx^2}{2}-\frac{x^3}{3}\right]_0^k=1$	A1
	$\frac{3k^3}{64}-\frac{3k^3}{96}=1$	M1 dep
	$3k^3-2k^3=64$	
	$k^3=64$	
	$k=4$	A1cso
		(4)
b	[E(X) =] 2	B1
		(1)
c	$E(X^2)=\int_0^4 \frac{3}{32}x^3(4-x)$	M1
	$=\left[\frac{3x^4}{32}-\frac{3x^5}{160}\right]_0^4$	
	$=\left[\frac{3\times4^4}{32}-\frac{3\times4^5}{160}\right]$	
	= 4.8	A1
	Var (X) = 4.8 – 4	M1
	= 0.8	A1
		(4)
d	$\int_{1.5}^{2.5}\frac{3}{32}x(4-x)=\left[\frac{3x^2}{16}-\frac{x^3}{32}\right]_{1.5}^{2.5}$ or $\int_0^{1.5}\frac{3}{32}x(4-x)=\left[\frac{3x^2}{16}-\frac{x^3}{32}\right]_0^{1.5}$	M1
	$=\frac{47}{128}=0.3671875$ $\quad$ $=\frac{81}{256}=0.31640625$	
	$1-\frac{47}{128}=\frac{81}{128}$ awrt 0.633 $\quad$ $2\times\frac{81}{256}=\frac{81}{128}$ awrt 0.633	M1depA1
		(3)
		Total 12

Notes

(a)

1st M1 for an attempt to multiply out bracket and for attempting to integrate f(x). Both $x^n \rightarrow x^{n+1}$

1st A1 for correct integration. Ignore limits for these two marks. Need $\frac{3}{32}\left(\frac{kx^2}{2}-\frac{x^3}{3}\right)$ oe

2nd M1 Dependent on the previous M mark being awarded. For correct use of correct limits and set equal to 1. No need to see 0 substituted in. For verifying they must have $\frac{3}{32}\left(\frac{4^3}{2}-\frac{4^3}{3}\right)$

2nd A1 cso or for verifying $\frac{3}{32}\left(\frac{4^3}{2}-\frac{4^3}{3}\right)$ = 1 **oe** eg $3(4)^3-2(4)^3=64$ and a correct comment "so k = 4"

(c)

1st M1 attempt to multiply out bracket and attempting $\int x^2 f(x)$ Limits not needed. Both $x^n \rightarrow x^{n+1}$

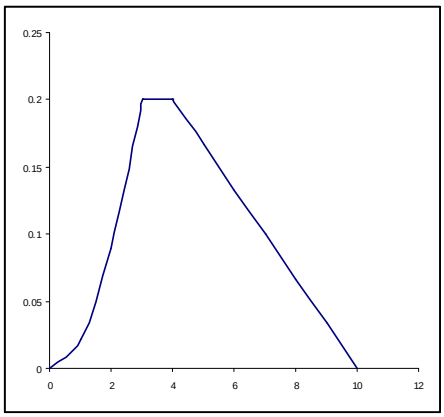
2nd M1 for their $E(X^2)$ – (their mean)^2

(d)

1st M1 Multiply out brackets, attempting to integrate (both $x^n \rightarrow x^{n+1}$), with either limits (their(b) ± 0.5) or (their (b) – 0.5 and 0) Accept 2 sf for their limits.

2nd M1dep on gaining 1st M1. 1 – (using limits (their(b) ±0.5)) or 2 × (using limits (their(b) – 0.5 and 0)

Question Number	Scheme	Marks
6	Attempt to write down combinations — at least one seen	**M1**
	(1,1,1), (1,1,2) any order (1,2,2) any order, (2,2,2) — no extra combinations	**A1**
	Range 0 and 1 — 0 and 1 only	**B1**
	[P(range = 0) =] $(0.65)^3 + (0.35)^3$ — either range	**M1**
	$= 0.3175$ or $\frac{127}{400}$	**A1cao**
	[P(range = 1) =] $(0.35)^2(0.65) \times 3 + (0.65)^2(0.35) \times 3$	
	$= 0.6825$ or $\frac{273}{400}$	**A1cao**
		(6)
		Total 6
	Notes	
	First M1 may be implied by either $(0.65)^3$ or $(0.35)^3$or $(0.65)^2(0.35)$ or $(0.35)^2(0.65)$ First A1 may be implied by $(0.65)^3$ **and** $(0.35)^3$ **and** $(0.65)^2(0.35)$ **and** $(0.35)^2(0.65)$ No need for x3 2nd M1 $(p)^3 + (1-p)^3$ or $(1-p)^2(p) \times 3 + (p)^2(1-p) \times 3$ A1 for 0.3175 cao or exact equivalent e.g $\frac{254}{800}$ A1 for 0.6825 cao or exact equivalent e.g $\frac{546}{800}$ NB These probabilities do not need to be associated with the correct range	

Question Number	Scheme	Marks
7(a)		**B1** **B1** **B1** **B1dep** **0.2,3,4,10** **(4)**
(b)	$F(x) = \begin{cases} 0 & x < 0 \\ \frac{x^3}{135} & 0 \le x \le 3 \\ \frac{x}{5} - \frac{2}{5} & 3 < x < 4 \\ \frac{x}{3} - \frac{x^2}{60} - \frac{2}{3} & 4 \le x \le 10 \\ 1 & x > 10 \end{cases}$	**M1A1** **M1A1** **M1A1**
	1st M1 For $0 \le x \le 3$, $F(x) = \int_0^x \frac{t^2}{45} dt$ $= \left[\frac{t^3}{135}\right]_0^x$	
	2nd M1 For $3 < x < 4$, $F(x) = \int_3^x \frac{1}{5} dt + \frac{1}{5}$ or $F(x) = \int \frac{1}{5} dx + C$ and uses $F(3) = \frac{1}{5}$ $= \left[\frac{t}{5}\right]_3^x + \frac{1}{5}$ $\frac{1}{5} = \left[\frac{3}{5}\right] + C$	
	3rd M1 For $4 \le x \le 10$, $F(x) = \int_4^x \frac{1}{3} - \frac{x}{30} dt + \frac{2}{5}$ or $F(x) = \int \frac{1}{3} - \frac{x}{30} dx + C$ and uses $F(4) = \frac{2}{5}$ or $F(10) = 1$ $F(x) = \left[\frac{t}{3} - \frac{t^2}{60}\right]_4^x + \frac{2}{5}$ $\frac{2}{5} = \frac{4}{3} - \frac{4^2}{60} + C$ or $1 = \frac{10}{3} - \frac{10^2}{60} + C$	
	Top line of $F(x)$ ie 0 $x < 0$ Bottom line of $F(x)$ ie 1 $x > 10$	**B1** **B1** **(8)**
(c)	$F(8) = \frac{8}{3} - \frac{8^2}{60} - \frac{2}{3}$ $= \frac{14}{15} = 0.933$	**M1** **A1 cso** **(2)** **Total 14**

	Notes	
(a)	1st B1 for a curve. It must start at (0, 0) and have the correct curvature. 2nd B1 for a horizontal line that joins the first section of the graph (not by a dotted line) 3rd B1 for a straight line with negative gradient that joins the horizontal line and stops on the positive x axis. 4th B1 dependent on first 3 marks being gained. Fully correct graph with labels 0.2, 3,4,10 in correct places	
(b)	For all the M marks, the attempt to integrate must have at least one $x^n \rightarrow x^{n+1}$ All A marks are for the correct expressions and ranges. Do not penalise the use of $\leq$ instead of $<$ and $\geq$ instead of $>$. **1st M1** for attempt to integrate $\int_0^x \frac{t^2}{45}\mathrm{d}t$ ignore limits **2nd M1** for attempt to integrate $\int_3^x \frac{1}{5}\mathrm{d}t + \text{their F(3)}$ using correct limits. **or** for attempt to integrate $\int \frac{1}{5}\mathrm{d}x + \mathrm{C}$ and substituting in 3 and putting = to their F(3) or substituting in 4 and putting = to their F(4) from their $4 \leq x \leq 10$ line **3rd M1** for attempt to integrate $\int_4^x \frac{1}{3} - \frac{x}{30}\mathrm{d}t + \text{their F(4)}$ using correct limits. **or** for attempt to integrate $\int \frac{1}{3} - \frac{x}{30}\mathrm{d}t + \mathrm{C}$ and substituting in 4 and putting = to their F(4) or substituting in 10 and putting = 1	
(c)	M1 substituting 8 into the 4th line of their cdf **or** F(3) + F(4) – F(3) + F(8) – F(4) or $1 - \int_8^{10} \frac{1}{3} - \frac{x}{30}$ (attempt to integrate needed) or use areas e.g $1 - \frac{1`}{2} \times 2 \times \frac{1}{15}$ or $1 - \frac{1}{15}$ A1 14/15 awrt 0.933 from correct working. NB If using F(3) + F(4) – F(3) + F(8) – F(4) then F(x) must be correct.	

Question Number	Scheme	Marks
8(a)	Let X be the random variable the number of customers asking for water.	
(i)	$X \sim B(10,0.6)$; $Y \sim B(10,0.4)$ — B1	
	$P(X = 6) = (0.6)^6(0.4)^4 \frac{10!}{6!4!}$; $P(Y = 4) = (0.4)^4(0.6)^6 \frac{10!}{6!4!}$ — M1	
	$= 0.2508\ldots$; $= 0.2508$; awrt 0.251 — A1	
(ii)	$X \sim B(10,0.6)$; $Y \sim B(10,0.4)$	
	$P(X < 9) = 1 - (P(X = 10) + P(X = 9))$ $= 1 - (0.6)^{10} - (0.6)^9(0.4)^1 \frac{10!}{9!1!}$; $P(X < 9) = 1 - P(Y \leq 1)$ $= 1 - 0.0464$ — M1	
	$= 0.9536\ldots$; $= 0.9536\ldots$; awrt 0.954 — A1	
		(5)
(b)	$X \sim B(50,0.6)$ — M1	
	$Y \sim B(50,0.4)$	
	$P(X < n) \geq 0.9$	
	$P(Y > 50 - n) \geq 0.9$ or $P(X < 34) = 0.8439$ awrt 0.844	
	$P(Y \leq 50 - n) \leq 0.1$ $P(X < 35) = 0.9045$ awrt 0.904/0.905 — M1	
	$50 - n \leq 15$	
	$n \geq 35$	
	$n = 35$ — A1	
		(3)
		Total 8

Notes

(a) B1 writing or using B(10,0.6) / B(10,0.4) in either part(i) or (ii)

(i) M1 $(0.6)^6(1-0.6)^4 \frac{10!}{6!4!}$ Allow ${}^{10}C_6$ oe

or writing or using $P(X \leq 6) - P(X \leq 5)$ if using B(10,0.6)

or $P(X \leq 4) - P(X \leq 3)$ if using B(10,0.4)

NB use of Poisson will gain M0A0

(ii) M1 writing or using $1 - (P(X = 10) + P(X = 9))$ if using B(10,0.6)

or

$1 - P(Y \leq 1)$ if using B(10,0.4)

NB use of Poisson will gain M0A0

(b) 1st M1 for writing or using either B(50,0.6) or B(50,0.4)

2nd M1 $P(Y > 50 - n) \geq 0.9$ or $P(Y \leq 50 - n) \leq 0.1$ or $P(X < 34)$ = awrt 0.844 or $P(X < 35)$ = awrt 0.904/0.905 or $50 - n = 15$ or $50 - n = 16$ or $50 - n \leq 15$ or $50 - n \leq 16$ – allow different letters

A1 cao 35. Do not accept $n \geq 35$ for final A1.

SC use of normal.

M1 M0 A0 for use of N(30,12) leading to an answer of 35