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Pearson Edexcel Level 3 GCE

Time 1 hour 30 minutes

Paper
reference

9FM0/3B

Further Mathematics

Advanced

PAPER 3B: Further Statistics 1

You must have:

Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or 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).
- **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 in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear.
- Answers without working may not gain full credit.
- Values from statistical tables should be quoted in full. If a calculator is used instead of the tables the value should be given to an equivalent degree of accuracy.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 75.
- 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.

Turn over ►

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Q:1/1/1/1/




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1. A researcher is investigating the number of female cubs present in litters of size 4. He believes that the number of female cubs in a litter can be modelled by $B(4, 0.5)$. He randomly selects 100 litters each of size 4 and records the number of female cubs. The results are recorded in the table below.

Number of female cubs	0	1	2	3	4
Observed number of litters	10	33	33	15	9

He calculated the expected frequencies as follows

Number of female cubs	0	1	2	3	4
Expected number of litters	6.25	r	s	r	6.25

- (a) Find the value of r and the value of s (3)
- (b) Carry out a suitable test, at the 5% level of significance, to determine whether or not the number of female cubs in a litter can be modelled by $B(4, 0.5)$. You should clearly state your hypotheses and the critical value used. (6)

(a) $X \rightarrow \# \text{ of female cubs}$

$$X \sim B(4, 0.5)$$

$$r = P(X=1) \times 100 = 25 \quad \text{M1}$$

↑
multiply by total # of litters

$$s = P(X=2) \times 100 = 37.5$$

$$\therefore r = 25, s = 37.5 \quad \text{A1A1}$$



Question 1 continued

(b) Hypotheses

H_0 : $B(4, 0.5)$ is a suitable model

H_1 : $B(4, 0.5)$ is not a suitable model

# of cubs	0	1	2	3	4
O_i	10	33	33	15	9
E_i	6.25	25	37.5	25	6.25
$\frac{O_i^2}{E_i}$	16	43.56	29.04	9	12.96

★ no pooling since all $E_i > 5$

Formula:

Use $\chi^2 = \sum \frac{O_i^2}{E_i} - N$ to get our test statistic

$$\begin{aligned}\chi^2 &= \overbrace{16 + 43.56 + 29.04 + 9 + 12.96}^{\sum \frac{O_i^2}{E_i}} - \overbrace{100}^{-N} \\ &= 110.56 - 100 \\ &= 10.56 \quad \text{test statistic} \quad \text{A1}\end{aligned}$$

Degrees of freedom:

5 rows & 1 restriction $\therefore \text{dof} = 5 - 1$

$$= 4 \quad \text{B1}$$

Critical value from tables:

$$\chi^2_4(5\%) = 9.488 \quad \text{critical value} \quad \text{B1}$$

Compare critical value + test statistic:

$10.56 > 9.488 \therefore$ significant evidence to reject H_0 and $\therefore$ significant evidence that the model is not suitable. A1

(Total for Question 1 is 9 marks)



2. The discrete random variable X has probability distribution

x	-5	-1	0	5	b
$P(X=x)$	0.3	0.25	0.1	0.15	0.2

where b is a constant and $b > 5$

(a) Find $E(X)$ in terms of b

(1)

Given that $\text{Var}(X) = 34.26$

(b) find the value of b

(4)

(c) Find $P(X^2 < 2 - 3X)$

(4)

Formulae for Mean and Variance

$$E(X) = \sum x P(X=x) \quad \text{mean, } \mu$$

$$E(X^2) = \sum x^2 P(X=x) \quad \text{mean of squares}$$

$$\text{Var}(X) = E(X^2) - [E(X)]^2 \quad \text{variance, } \sigma^2$$

$$\begin{aligned} \text{(a)} \quad E(X) &= -5(0.3) - 1(0.25) + 0(0.1) + 5(0.15) + 0.2b \\ &= -1.5 - 0.25 + 0.75 + 0.2b \\ &= 0.2b - 1 \quad \text{B1} \end{aligned}$$

x	-5	-1	0	5	b
x^2	25	1	0	25	b^2
$P(X=x)$	0.3	0.25	0.1	0.15	0.2

$$\begin{aligned} E(X^2) &= 25(0.3) + 1(0.25) + 0(0.1) + 25(0.15) + b^2(0.2) \\ &= 11.5 + 0.2b^2 \quad E(X^2) \quad \text{M1} \end{aligned}$$

$$\text{from (a)} \rightarrow E(X) = 0.2b - 1$$

Substitute $E(X^2)$ and $E(X)$ into formula for Variance:

$$\begin{aligned} \text{Var}(X) &= E(X^2) - [E(X)]^2 \quad \text{given value for Var}(X) \\ &= 11.5 + 0.2b^2 - (0.2b - 1)^2 = 34.26 \quad \text{M1} \end{aligned}$$

$$11.5 + 0.2b^2 - 0.04b^2 + 0.4b - 1 = 34.26$$

$$\text{solve } 0.16b^2 + 0.4b - 23.76 = 0 \quad \text{Quadratic} \quad \text{M1}$$

$$b = 11 \text{ or } b = -13.5$$

given that $b > 5 \therefore$ reject $b = -13.5$

$$b = 11 \quad \text{value of } b \quad \text{A1}$$

Question 2 continued

(c) To tackle this question we need to calculate values for x^2 and $2-3x$. For x^2 we did this in (b), so let's add a new row to the table for $2-3x$:

x	-5	-1	0	5	11
x^2	25	1	0	25	121
$2-3x$	17	5	2	-13	-31
$P(X=x)$	0.3	0.25	0.1	0.15	0.2

M1A1

use our b value from (b)

to get these values we just substitute

each x value into $2-3x$, e.g. $x=-1$: $2-3(-1)=2+3=5$

To get $P(x^2 < 2-3x)$ we need to **sum** the **probabilities** of the columns where the x^2 value is **smaller** than the $2-3x$ value:

x^2	25	1	0	25	121
$2-3x$	17	5	2	-13	-31
$P(X=x)$	0.3	0.25	0.1	0.15	0.2

In these 2 rows $x^2 < 2-3x$

→ Add the 3 Probabilities:

M1 $P(x^2 < 2-3x) = 0.25 + 0.1$ ($P(x=-1) + P(x=0)$)

A1 $= 0.35$

(Total for Question 2 is 9 marks)



3. During the summer, mountain rescue team A receives calls for help randomly with a rate of 0.4 per day. Poisson

- (a) Find the probability that during the summer, mountain rescue team A receives at least 19 calls for help in 28 randomly selected days. (2)

The leader of mountain rescue team A randomly selects 250 summer days from the last few years.

She records the number of calls for help received on each of these days.

- (b) Using a Poisson approximation, estimate the probability of the leader finding at least 20 of these days when more than 1 call for help was received by mountain rescue team A . (4)

Mountain rescue team A believes that the number of calls for help per day is lower in the winter than in the summer. The number of calls for help received in 42 randomly selected winter days is 8.

- (c) Use a suitable test, at the 5% level of significance, to assess whether or not there is evidence that the number of calls for help per day is lower in the winter than in the summer. State your hypotheses clearly. (4)

During the summer, mountain rescue team B receives calls for help randomly with a rate of 0.2 per day, independently of calls to mountain rescue team A .

The random variable C is the total number of calls for help received by mountain rescue teams A and B during a period of n days in the summer.

On a Monday in the summer, mountain rescue teams A and B each receive a call for help.

Given that over the next n days $P(C = 0) < 0.001$

- (d) calculate the minimum value of n (3)
- (e) Write down an assumption that needs to be made for the model to be appropriate. (1)

(a) In 1 day $\rightarrow 0.4$ calls

In 28 days $\rightarrow 0.4 \times 28 = 11.2$ calls

$S \rightarrow \#$ of calls received in 28 days define variable

$S \sim \text{Po}(11.2)$

$P(S \geq 19) = 1 - P(S \leq 18)$ M1

$= 0.020776 \rightarrow 0.021$ to 2sf. A1



Question 3 continued

(b) $A \rightarrow \#$ of calls received in 1 day

$$A \sim \text{Po}(0.4)$$

B1 $P(A > 1) = 0.061551$ probability for more than 1 call per day $X \rightarrow \#$ of days with more than 1 call

M1 $X \sim B(250, 0.061551)$ get λ $\lambda = 250 \times 0.061551 = 15.388 \dots$

M1 $Y \sim \text{Po}(15.388)$ poisson approx.

$$P(Y \geq 20) = 1 - P(Y \leq 19)$$

$$= 0.14751 \rightarrow 0.148 \text{ to 3sf} \quad \text{A1}$$

(c) Hypotheses

$$H_0: \lambda = 0.4 \quad x42 \rightarrow H_0: \mu = 16.8 \text{ for 42 days}$$

$$H_1: \lambda < 0.4 \quad H_1: \mu < 16.8 \quad \text{B1}$$

 $W \rightarrow \#$ of calls per day in winter

$$W \sim \text{Po}(16.8) \quad \text{B1}$$

$$P(W \leq 8) = 0.014 < 0.05 \therefore \text{sufficient evidence to reject } H_0 \text{ and that the \# of calls per day is lower in winter}$$

given value M1A1

(d) Since calls to A and B are independent, we can add the two variables

for A $\rightarrow$ rate of calls in n days: $0.4n$ for B $\rightarrow$ rate of calls in n days: $0.2n$ +rate for C: $0.6n$

$$\therefore C \sim \text{Po}(0.6n) \quad \text{M1}$$

given $P(C=0) < 0.001$

Formula for Poisson Distribution:

Substitute:

$$\frac{e^{-0.6n} \times (0.6n)^0}{0!} < 0.001$$

$$e^{-0.6n} < 0.001$$

$$\ln e^{-0.6n} < \ln 0.001$$

$$-0.6n < \ln 0.001$$

$$n > \frac{\ln 0.001}{-0.6}$$

$$n > 11.5 \rightarrow n = 12 \text{ smallest value} \quad \text{M1A1}$$

apply $\ln$ to both sides $\ln$ rule: $\ln e^x = x$

flip inequality sign when you divide by a negative!

(e) Rate of calls per day constant

Number of calls per day is independent B1



Question 3 continued

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Question 3 continued

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(Total for Question 3 is 14 marks)



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4. In a game a spinner is spun repeatedly. When the spinner is spun, the probability of it landing on blue is 0.11

(a) Find the probability that the spinner lands on blue

(i) for the first time on the 6th spin, **geo**

(2)

(ii) for the first time before the 6th spin, **geo**

(2)

(iii) exactly 4 times during the first 6 spins, **bin**

(2)

(iv) for the 4th time on or before the 6th spin, **neg. bin**

(4)

Zac and Izana play the game. They take turns to spin the spinner. The winner is the first one to have the spinner land on blue. Izana spins the spinner first.

(b) Show that the probability of Zac winning is 0.471 to 3 significant figures.

(3)

(a) $W \rightarrow$ Number of spins until it lands on blue **define variable**

$$W \sim \text{Geo}(0.11)$$

$$(i) P(W=6) = (0.11)(0.89)^5 = 0.06142 \rightarrow 0.0614 \text{ to 3sf} \quad \text{M1A1}$$

$$(ii) P(W < 6) = P(W \leq 5) = 1 - (0.89)^5 = 0.44159 \rightarrow 0.442 \text{ to 3sf} \quad \text{M1A1}$$

"one minus the probability it doesn't land on blue within the first 5 tries".

(iii) $X \rightarrow$ # of times it lands on blue **define variable**

$$X \sim B(6, 0.11) \quad \text{M1}$$

$$P(X=4) = 0.001739 \rightarrow 0.00174 \text{ to 3sf} \quad \text{A1}$$

(iv) $Y \rightarrow$ # of times it takes to land on blue 4 times

$$Y \sim \text{NegB}(4, 0.11) \quad \text{M1}$$

We want 4 successes within a maximum of 6 tries, so we want the fourth success to be on trial 4, 5 or 6

$$P(Y \leq 6) = P(Y=4) + P(Y=5) + P(Y=6) \quad \text{M1}$$

$$= (0.11)^4 + \binom{4}{3}(0.11)^4(0.89) + \binom{5}{3}(0.11)^4(0.89)^2 \quad \text{M1}$$

$$= 0.001827 \rightarrow 0.00183 \text{ to 3sf} \quad \text{A1}$$



Question 4 continued

(b) $P(\text{zac wins}) = 0.89 \times 0.11 + (0.89)^3 (0.11) + (0.89)^5 (0.11) + \dots$ - recognize this as geometric sequence,
 he lands/ lands blue etc M1 $\alpha = 0.89 \times 0.11$ and $r = 0.89$
 blue on his 1st try on 2nd try

Formula for geometric sequence sum to infinity:

$$S_{\infty} = \frac{a}{1-r}$$

Substitute:

$$S_{\infty} = \frac{0.89 \times 0.11}{1 - (0.89)^2} = 0.47089 \rightarrow 0.471 \text{ to 3sf probability that zac wins M1A1}$$

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

$$E = mc^2$$

$$a^2 + b^2 = c^2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$(a+b)^2 = a^2 + 2ab + b^2$$

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Question 4 continued

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(Total for Question 4 is 13 marks)



5. A random sample of 150 observations is taken from a geometric distribution with parameter 0.3

Estimate the probability that the mean of the sample is less than 3.45

(5)

"mean of sample"

From the wording of the exercise we can deduce that it's about the central limit theorem.

$$X \sim \text{Geo}(0.3)$$

Get μ and σ :

For Geometric from Formula Booklet:

$$E(X) = \frac{1}{p} \quad \text{and} \quad \text{Var}(X) = \frac{1-p}{p^2}$$

$$\mu = E(X) = \frac{1}{0.3} = \frac{10}{3}$$

$$\sigma^2 = \text{Var}(X) = \frac{1-0.3}{0.3^2} = \frac{70}{9}$$

$$N = 150$$

CLT: $X \sim \text{Geo}(p)$ for Sample size N : $\bar{X} \approx N\left(\mu, \frac{\sigma^2}{N}\right)$

$$\therefore \text{For } X \sim \text{Geo}(0.3) \rightarrow \bar{X} \approx N\left(\frac{10}{3}, \frac{70}{9}\right)$$

$$\bar{X} \approx N\left(\frac{10}{3}, \frac{70}{9 \times 150}\right)$$

$$\bar{X} \approx N\left(\frac{10}{3}, \frac{7}{135}\right) \quad \text{In your calculator, enter } \frac{\sqrt{70}}{\sqrt{150}} \text{ to get the right result!}$$

$$P(\bar{X} < 3.45) = 0.69579 \rightarrow 0.696 \text{ to 3sf}$$



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Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 5 marks)



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6. The discrete random variable V has probability distribution

v	2	3	4
$P(V = v)$	$\frac{9}{25}$	$\frac{12}{25}$	$\frac{4}{25}$

- (a) Show that the probability generating function of V is

$$G_V(t) = t^2 \left(\frac{2}{5}t + \frac{3}{5} \right)^2 \quad (2)$$

The discrete random variable W has probability generating function

$$G_W(t) = t \left(\frac{2}{5}t + \frac{3}{5} \right)^5$$

- (b) Use calculus to find

(i) $E(W)$ (2)

(ii) $\text{Var}(W)$ (4)

Given that V and W are independent,

- (c) find the probability generating function of $X = V + W$ in its simplest form. (2)

The discrete random variable $Y = 2X + 3$

- (d) Find the probability generating function of Y (2)

- (e) Find $P(Y = 15)$ (2)

- (a) We know that the value of v is the power of t and the probability is the coefficient

$$\begin{aligned} G_V(t) &= \frac{9}{25}t^2 + \frac{12}{25}t^3 + \frac{4}{25}t^4 && \text{use values from table (M1)} \\ &= t^2 \left(\frac{9}{25} + \frac{12}{25}t + \frac{4}{25}t^2 \right) && \text{factor out } t^2 \\ &= t^2 \left(\frac{2}{5}t + \frac{3}{5} \right)^2 && \text{factorize bracket further} \end{aligned}$$

(A1)



Question 6 continued

(b) For PGFs:

$$E(X) = G'_X(1)$$

$$\text{Var}(X) = G''_X(1) + G'_X(1) - [G'_X(1)]^2$$

i. $G_W(t) = t\left(\frac{2}{5}t + \frac{3}{5}\right)^5$

$$G'_W(t) = t\left(\frac{2}{5}t + \frac{3}{5}\right)^4 \times \frac{2}{5} + \left(\frac{2}{5}t + \frac{3}{5}\right)^5$$

$$G'_W(t) = 2t\left(\frac{2}{5}t + \frac{3}{5}\right)^4 + \left(\frac{2}{5}t + \frac{3}{5}\right)^5$$

$$G'_W(1) = 2(1)\left(\frac{2}{5}(1) + \frac{3}{5}\right)^4 + \left(\frac{2}{5} + \frac{3}{5}\right)^5$$

Substitute 1 into derivative equation

$$= 2\left(\frac{2}{5} + \frac{3}{5}\right)^4 + \left(\frac{2}{5} + \frac{3}{5}\right)^5 \quad \text{M1}$$

$$= 2(1)^4 + (1)^5$$

$$= 2 + 1 = 3 \quad \therefore E(W) = 3 \quad \text{A1}$$

ii. Let's get $G''_W(t)$ by differentiating $G'_W(t)$ again:

$$G'_W(t) = 2t\left(\frac{2}{5}t + \frac{3}{5}\right)^4 + \left(\frac{2}{5}t + \frac{3}{5}\right)^5$$

$$G''_W(t) = 5\left(\frac{2}{5}t + \frac{3}{5}\right)^4 \times \frac{2}{5} + 8t\left(\frac{2}{5}t + \frac{3}{5}\right)^3 \times \frac{2}{5} + 2\left(\frac{2}{5}t + \frac{3}{5}\right)^4$$

$$G''_W(t) = 2\left(\frac{2}{5}t + \frac{3}{5}\right)^4 + \frac{16}{5}t\left(\frac{2}{5}t + \frac{3}{5}\right)^3 + 2\left(\frac{2}{5}t + \frac{3}{5}\right)^4 \quad \text{M1}$$

$$G''_W(1) = 2(1)^4 + \frac{16}{5}(1)(1) + 2(1)^4$$

$$G''_W(1) = 2 + \frac{16}{5} + 2 = \frac{36}{5} \quad \text{A1}$$

Substitute $G'_W(1)$ from i. and $G''_W(1)$ into $\text{Var}(W) = G''_W(1) + G'_W(1) - [G'_W(1)]^2$

$$\text{Var}(W) = \frac{36}{5} + 3 - (3)^2 \quad \text{M1}$$

$$\text{Var}(W) = \frac{6}{5} \quad \text{A1}$$

(c) $X = V + W$ $\downarrow$

$$G_X(t) = G_V(t) \times G_W(t)$$

$$G_X(t) = t^2\left(\frac{2}{5}t + \frac{3}{5}\right)^2 \times t\left(\frac{2}{5}t + \frac{3}{5}\right)^5 \quad \text{M1}$$

$$= t^3\left(\frac{2}{5}t + \frac{3}{5}\right)^7 \quad \text{A1}$$

(d) $Y = 2X + 3$ PGF of X from (c)

$$G_Y(t) = G_X(t^2) \times t^3$$

$$= (t^2)^3\left(\frac{2}{5}t^2 + \frac{3}{5}\right)^7 \times t^3 \quad \text{M1}$$

$$= t^6\left(\frac{2}{5}t^2 + \frac{3}{5}\right)^7 \times t^3$$

$$G_Y(t) = t^9\left(\frac{2}{5}t^2 + \frac{3}{5}\right)^7 \quad \text{A1}$$

use chain rule and product rule

★chain rule: multiply by

the derivative of the bracket!

★Product Rule:

$$\frac{d}{dx}(uv) = uv' + u'v$$



Question 6 continued

(e) $P(Y=15) \Rightarrow$ coefficient of t^{15} in the expansion of $G_Y(t)$ we found in (d)

Use Binomial expansion

$$G_Y(t) = \dots t^9 \times \binom{3}{3} \times \left(\frac{2}{5}t^2\right)^3 \times \left(\frac{3}{5}\right)^4 \quad \text{M1}$$

to figure out which term you need look at the powers you have:

t^9 won't change as it's not in the expansion, $\therefore$ we need " $\left(\frac{2}{5}t^2\right)^3$ " to turn t^9 into t^{15} ($t^9 \times t^6 = t^{15}$ - rules of indices). $\therefore x=3$

$$G_Y(t) = t^9 \times 35 \times \frac{8}{125} t^6 \times \frac{81}{625}$$

$$= \frac{4536}{15625} t^{15}$$

coefficient $\rightarrow$ probability

$$\therefore P(Y=15) = 0.2903 \quad \text{A1}$$

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(Total for Question 6 is 14 marks)

7. A machine fills bags with flour. The weight of flour delivered by the machine into a bag, X grams, is normally distributed with mean μ grams and standard deviation 30 grams. To check if there is any change to the mean weight of flour delivered by the machine into each bag, Olaf takes a random sample of 10 bags. The weight of flour, x grams, in each bag is recorded and $\bar{x} = 1020$

- (a) Test, at the 5% level of significance, $H_0: \mu = 1000$ against $H_1: \mu \neq 1000$ (4)

Olaf decides to alter the test so that the hypotheses are $H_0: \mu = 1000$ and $H_1: \mu > 1000$ but keeps the level of significance at 5%

He takes a second sample of size n and finds the critical region, $\bar{X} > c$

- (b) Find an equation for c in terms of n (2)

When the true value of μ is 1020 grams, the probability of making a Type II error is 0.0050, to 2 significant figures.

- (c) Calculate the value of n and the value of c (5)

$$(a) \bar{X} \sim N(1000, \frac{30^2}{10}) \quad (M1)$$

as the found value, 1020g, is $> 1000g$, test upper tail:

$$P(\bar{X} > 1020) = 0.0175 < 0.025 - \frac{0.05}{2} \text{ as it's two tailed} \quad (M1A1)$$

$\therefore$ Reject H_0 . Sufficient evidence to suggest that the mean weight of flour in a bag changed

(A1)

$$(b) \bar{X} \sim N(1000, \frac{900}{n})$$

$$\hookrightarrow \frac{c-1000}{\frac{30}{\sqrt{n}}} = \text{InvN}(0.95) = 1.6449 \rightarrow c-1000 = \frac{30}{\sqrt{n}} \times 1.6449 \quad (M1)$$

$\frac{c-\mu}{\sigma}$, coding to standard normal

$$c = 1000 + \frac{49.347}{\sqrt{n}} \text{ equation for } c \text{ in } n \quad (A1)$$

- (c) Type II Error is the probability of falsely accepting H_0 . (H_0 is false but we accept it)

$$\bar{X} \sim N(1020, \frac{900}{n})$$

We want the probability of not being in the critical region, $\bar{X} < c$, with $\mu=1020$ and $\sigma = \frac{30}{\sqrt{n}}$:

Code our c : given prob. of type II error

$$\frac{c-1020}{\frac{30}{\sqrt{n}}} = \text{Inv}(0.005) = -2.5758$$

Substitute the equation for c we got in part (b):

$$\frac{1000 + \frac{49.347}{\sqrt{n}} - 1020}{\frac{30}{\sqrt{n}}} = -2.5758 \quad (M1A1)$$

Solve:

$$\frac{49.347}{\sqrt{n}} + \frac{77.275}{\sqrt{n}} = 20 \rightarrow 20 = \frac{126.621}{\sqrt{n}} \quad (M1)$$

(A1)

$$n = 40$$

$\rightarrow$ subst. this into $c = \dots$ to get c

(A1)

$$c = 1007.8$$



Question 7 continued

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Question 7 continued

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Question 7 continued

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DO NOT WRITE IN THIS AREA

(Total for Question 7 is 11 marks)

TOTAL FOR PAPER IS 75 MARKS

