Pearson Edexcel

Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCE
A Level Further Mathematics (9FM0)
Paper 3B -Further Statistics 1

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2022
Question Paper Log Number P69194A*
Publications Code 9FM0_3B_2206_MS*
All the material in this publication is copyright
© Pearson Education Ltd 2022

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS
General Instructions for Marking

1. The total number of marks for the paper is 80.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\sqrt{}$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

5. Where a candidate has made multiple responses <u>and indicates which response they wish to submit</u>, examiners should mark this response.
   If there are several attempts at a question <u>which have not been crossed out</u>, examiners should mark the final answer which is the answer that is the <u>most complete</u>.

6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

Qu	Scheme	Marks	AOs
1(a)	$r = \mathrm{P}(X=3)\times 100$ or $r = \mathrm{P}(X=1)\times 100$ or $s = \mathrm{P}(X=2)\times 100$	M1	3.4
	$r =$ **25** (value may be in table)	A1	1.1b
	$s =$ **37.5** (value may be in table)	A1	1.1b
		(3)	
(b)	H_0: B(4,0.5) is a suitable model (o.e.) Condone B(0.5, 4) H_1: B(4,0.5) is not a suitable model (o.e.)	B1	2.5
	$\frac{(O_i-E_i)^2}{E_i}$: 2.25, 2.56, 0.54, 4, 1.21 $\frac{O_i^2}{E_i}$: 16, 43.56, 29.04, 9, 12.96	M1	1.1b
	$\sum\frac{(O_i-E_i)^2}{E_i} = 10.56$ or $\sum\frac{O_i^2}{E_i} - N = 110.56 - 100 = 10.56$ $\left(=\frac{264}{25}\right)$	A1	1.1b
	$\nu = 5-1 = 4$	B1	1.1b
	CV = 9.488 (Calc 9.487729035…)	B1ft	1.1b
	Significant so there is evidence that the researcher's **model is not suitable**	A1	2.2b
		(6)	
			Total 9

(a)	**M1**	Using the Binomial model to expected value. Allow if both probs 0.25 and 0.375 seen May be implied by a correct value of r or s. Alternatives $r = 6.25\times 4$ or $s = 6.25\times 6$
	1st A1	for $r = 25$
	2nd A1	for $s = 37.5$
SC	**"B1"**	If M0 scored but their values of r and s satisfy $2r + s = 87.5$ score as **M0A0A1**
(b)	**1st B1**	Both hypotheses correct using the correct notation in at least one or written in full e.g. binomial with $n = 4$ and $p = 0.5$
	M1	Calculating either $\frac{(O_i-E_i)^2}{E_i}$ or $\frac{O_i^2}{E_i}$ at least 4 correct. Implied by sight of awrt 10.6
	1st A1	Allow 10.6 (from correct working)
	2nd B1	Correct dof May be implied by CV of 9.48 or 9.49 or better
	3rd B1ft	For 9.488 or better. Can ft their dof NB $\chi_3^2(5\%) = 7.815$ (allow awrt 7.815)
	2nd A1	**Indep'of hypotheses but dep on 1st A1** Evaluating the outcome by drawing a correct inference. Compatible with comparison of 10.56 or 10.6 with their CV (which must be > 1) They must say **model not suitable** (o.e.) They do not need to state the comparison or say reject H_0 etc No need to explicitly see B(4, 0.5) mentioned here

Question	Scheme	Marks	AOs

2(a)	$\left[\mathrm{E}(X)=\right]0.2b-1$	B1 **(1)**	1.1b
(b)	$\mathrm{E}(X^2)=25\times0.3+1\times0.25[+0\times0.1]+25\times0.15+0.2b^2\left[=11.5+0.2b^2\right]$ $"11.5+0.2b^2"-("0.2b-1")^2\left[=34.26\right]$ $0.16b^2+0.4b-23.76[=0]$ <u>or</u> $\frac{4}{25}b^2+\frac{2}{5}b-\frac{594}{25}[=0]$ $b=$ **<u>11</u>** [since $b>5$]	M1 M1 M1 A1 **(4)**	1.1b 3.1a 1.1b 2.2a
(c)			

X	–5	–1	0	5	"11"
X^2	25	1	0	25	"121"
$2-3X$	17	5	2	– 13	"– 31"
X^2-2	23	–1	–2	23	"119"
$-3X$	15	3	0	15	"–33"
X^2+3X	10	–2	0	40	"154"
X^2+3X-2	8	–4	–2	38	"152"

	M1 A1ft	2.1 1.1b
$\mathrm{P}(X^2<2-3X)=\mathrm{P}(X=-1)+\mathrm{P}(X=0)$	M1	2.2a
$=$ **<u>0.35</u>**	A1 **(4)**	1.1b
		Total 9

(a)	**B1**	Correct expression for $\mathrm{E}(X)$
(b)	**1st M1**	Correct attempt at $\mathrm{E}(X^2)$ using $\sum x^2\mathrm{P}(X=x)$ at least 3 correct non-zero products Allow $(-5)^2$ etc
	2nd M1	Realising that Var(X) = $\mathrm{E}(X^2)-[\mathrm{E}(X)]^2$ needs to be **used**
	3rd M1	Reducing their equation to a 3 term quadratic. At least 2 terms correct. Allow e.g. $0.16b^2+0.4b=23.76$ Condone missing "=0"
	A1	For 11 only (from the correct equation) so –13.5 must be eliminated Correct answer with no incorrect working seen scores 4/4
(c)	**1st M1**	At least 4 values correct for (X^2 **and** $2-3X$) <u>or</u> for (X^2-2 **and** $-3X$) <u>or</u> X^2+3X <u>or</u> X^2+3X-2 (o.e.) Allow for solving equation with one sign error
	1st A1ft	All correct or correct ft with their b but must have $b>5$ (accurate to 1 sf) Allow solving equation to get awrt –3.6 **and** awrt 0.56 <u>or</u> $\frac{-3\pm\sqrt{17}}{2}$ (ft their $b>5$) If there are omissions **but no errors** in the lists of values then if 2nd M1 and 2nd A1 are scored then the 1st M1 and 1st A1 can be given by implication.
	2nd M1	For identifying the correct values of X required i.e. $X=-1$ and $X=0$
	2nd A1	0.35 **NB** It is possible to score M0A0M1A1 here if their table of values is incorrect Correct answer with no incorrect working seen scores 4/4 (Allow correct use of their $b>5$)

Qu	Scheme	Marks	AOs
3(a)	$W \sim \text{Po}(11.2)$ and $\text{P}(W \ldots 19) = 1 - \text{P}(W \,,, 18)$ <u>or</u> suitable 3sf probs $\text{P}(W \ldots 19) = 0.020776...$ awrt **<u>0.021</u>**	M1 A1 **(2)**	3.4 1.1b
(b)	[S = # calls per day, $S \sim \text{Po}(0.4)$] $\text{P}(S > 1) = 0.061551...$ awrt 0.0616 $X \sim \text{B}(250, \text{“}0.061551..\text{”})$ $Y \sim \text{Po}(\text{“}15.3879\ldots\text{”})$ [Accept Po(15.4) or better] <u>or</u> suitable 3sf probs = 0.14751… awrt **<u>0.148</u>**	B1 M1 M1 A1 **(4)**	1.1b 3.3 3.4 1.1b
(c)	H_0: $\lambda = 16.8$ H_1: $\lambda < 16.8$ $U \sim \text{Po}(16.8)$ $\text{P}(U \,,, 8) = 0.014$ [0.014 < 0.05 or there is sufficient evidence to reject H_0] There is sufficient evidence at the 5% level of significance that the <u>number of calls</u> received <u>per day</u> is <u>lower</u> in winter **or** <u>rate of calls</u> is <u>lower</u> in winter **or** <u>less calls per day</u> in <u>winter</u> (o.e.)	B1 B1 M1 A1 **(4)**	2.5 3.3 1.1b 2.2b
(d)	$C \sim \text{Po}(0.4 \times n + 0.2 \times n)$ [= Po(0.6n)] <u>or</u> $D \sim \text{B}(n, \text{e}^{-0.6}$ or awrt 0.549) $\text{e}^{-0.6n} < 0.001$ <u>or</u> $-0.6n < \ln(0.001)$ <u>or</u> $n > 11.5\ldots$ n = **<u>12</u>**	M1 M1 A1 **(3)**	3.1b 1.1b 1.1b
(e)	The <u>rate of calls</u> per day is <u>constant</u> **or** the <u>number of calls</u> occurring in non-overlapping time <u>intervals</u> is <u>independent</u>. **or** <u>number of calls per day is independent</u> (o.e.)	B1 **(1)**	2.4
			Total 14

(a)	**M1** **A1**	For using the model Po(11.2) implied by sight of: 0.02077… or 0.9889.. or 0.9792.. awrt 0.021
(b)	**B1** **1st M1** **2nd M1** **A1** **SC**	awrt 0.0616 Setting up a new model B(250, “0.0616”) [condone B(“0.0616”, 250)] Seeing the model Po(their np) implied by sight of: 0.1475.. or 0.89975 or 0.8524… awrt 0.148 if **no approximation** used(and 1st M1 not seen) an answer of awrt 0.140 could get B1M1M0A0
(c)	**1st B1** **2nd B1** **M1** **A1**	Both hypotheses correct using λ or μ and 16.8 or 0.4 [Accept their ans to 0.4×42] Realising Po(16.8) needs to be used. Sight or use of, implied by correct prob or CR For 0.014 or better (0.0141..) or CR $X \,,, 9$ oe must be CR and not probability. [Allow CR $X \,,, 10$ with probability $\text{P}(X \,,, 10) = 0.054$ or better] **Indep of 1st B1** (must see 2nd B1 and M1 scored) for a correct inference in context
(d)	**1stM1** **2ndM1** **A1**	Selecting a suitable model. Sight of Po(0.6n) <u>or</u> B(n, $\text{e}^{-0.6}$) or implied by 2nd M1 For a correct inequality or equality involving n [Condone slips in solving] Allow **MR** i.e. misread of 0.01 for 0.001 (or similar) to score M1M1A0 n = 12 cao [Correct answer with no incorrect working seen scores 3/3]
(e)	**B1**	Allow equivalent statements. Underlined words required.

Question	Scheme	Marks	AOs
4(a) (i)	[$W \sim$ Geo(0.11)] $\quad P(W=6)=(0.89)^5(0.11)$	M1	3.3
	$= 0.06142\ldots$ | awrt **0.0614**	A1	1.1b
		(2)	
(ii)	$P(W \geq 5) = 1-(0.89)^5$	M1	3.1b
	$= 0.44159\ldots$ | awrt **0.442**	A1	1.1b
		(2)	
(iii)	$X \sim B(6, 0.11)$	M1	3.3
	$P(X=4)=0.001739\ldots$ | awrt **0.00174**	A1	1.1b
		(2)	
(iv)	[$Y \sim$ NB(4, 0.11)] using a neg bin | **or** $V \sim B(6, 0.11)$	M1	3.3
	$P(Y \geq 6)=P(Y=4)+P(Y=5)+P(Y=6)$ | **and** $P(V \ldots 4)$ for **M2**	M1	3.1b
	$= (0.11)^4+\binom{4}{3}(0.11)^3(0.89)^1\times 0.11+\binom{5}{3}(0.11)^3(0.89)^2\times 0.11$	M1	3.4
	$= 0.001827$ | awrt **0.00183**	A1	1.1b
		(4)	
(b)	P(Zac wins) = $0.89\times 0.11+(0.89)^3\times 0.11+(0.89)^5\times 0.11+\ldots$	M1	3.1b
	$=\dfrac{0.89\times 0.11}{1-(0.89)^2}$ oe	M1	1.1b
	$= 0.47089\ldots = 0.471$*	A1cso*	2.1
		(3)	
			Total 13

(a)(i)	**M1**	Correct method to find $P(W=6)$ eg $(p)^5(1-p)$ for $p = 0.11$ or 0.89
	A1	awrt 0.0614 (Correct ans with no incorrect working 2/2)
(ii)	**M1**	Correct method to find $P(W \geq 5)$
	A1	awrt 0.442 (Correct ans with no incorrect working 2/2)
(iii)	**M1**	For using the model B(6, 0.11) allow B(6, 0.89) [Implied by 0.0017 or awrt 0.114]
	A1	awrt 0.00174 (Correct ans with no incorrect working 2/2)
(iv)		In part (iv) we can accept correct expressions or values for probabilities
	1st M1	For using a negative binomial model implied by correct P($Y = 5$) or P($Y = 6$)
	2nd M1	Correct method to find $P(Y \geq 6)$
	3rd M1	At least two correct terms <u>or</u> 1 – 0.99817.. from 1 – P($V \geq 3$)
	A1	awrt 0.00183

a	4	5	6
$P(Y=a)$	1.46×10^{-4}	5.21×10^{-4}	1.16×10^{-3}
$P(V=a)$	1.74×10^{-3}	8.60×10^{-5}	1.77×10^{-6}

(b)	**1st M1**	Forming the correct probability of Zac winning <u>or</u> identify a and r of GP	Allow for $p=(0.11)\times 0+(1-0.11)(1-p)$
	2nd M1	Using sum to infinity of a GP	Allow for $p=\dfrac{0.89}{1+0.89}$
	A1*	Previous method marks must be seen leading to an answer 0.471 (NOT awrt 0.471)	

Question	Scheme	Marks	AOs
5	Geo (0.3) $\mu = \frac{1}{0.3}\left[\text{ or exact equivalent e.g. } \frac{10}{3}\right]$	B1	1.1b
	$\sigma^2 = \frac{1-0.3}{0.3^2}\left[\text{ or exact equivalent e.g. } \frac{70}{9}\right]$	B1	1.1b
	CLT $\Rightarrow \bar{X} \approx \mathrm{N}\left(\frac{10}{3},...\right)$ oe	M1	2.1
	$\Rightarrow \bar{X} \approx \mathrm{N}\left(\frac{10}{3},\frac{7}{135}\right)$ and attempt (sight of) $\mathrm{P}\left(\bar{X} < 3.45\right)$	M1	3.4
	$= 0.69579\ldots$ awrt **<u>0.696</u>**	A1	1.1b
		(5)	
			Total 5

1st B1	correct mean
2nd B1	correct Var may be implied by sight of $\frac{7}{135}$ in distribution of $\bar{X}$
1st M1	For use of CLT (must see $\bar{X}$ and Normal with mean correct ft) <u>or</u> sight of $\mathrm{N}\left(\frac{10}{3},\frac{7}{135}\right)$ <u>or</u> $\mathrm{N}\left(\text{"}\frac{10}{3}\text{"},\frac{\text{"70"}}{\text{"9"}\times 150}\right)$ with any letter Allow 3.33 or better for $\frac{10}{3}$ and 7.78 or better for $\frac{70}{9}$ May be implied by 2nd M1
2nd M1	Using the normal distribution to find $\mathrm{P}\left(\bar{X} < 3.45\right)$ ft their $\text{"}\frac{10}{3}\text{"}$ and $\frac{\text{"}\frac{70}{9}\text{"}}{150}$ May be implied by correct answer.
A1	awrt 0.696 Correct answer with no incorrect working scores 5/5

	Alternative (Use of $Y = \sum X$)	
	$\mu = \frac{150}{0.3}[= 500]$	B1
	$\sigma^2 = \frac{150\times 0.7}{0.3^2}\left[\frac{3500}{3}\right] = 1166.\dot{6}$	B1
	$\Rightarrow Y \approx \mathrm{N}\left(500,\frac{3500}{3}\right)$	M1
	$\mathrm{P}\left(Y < 517.5\right)$	M1
	$= 0.69579...$	A1

Question	Scheme	Marks	AOs
6(a)	$G_v(t)=\frac{9}{25}t^2+\frac{12}{25}t^3+\frac{4}{25}t^4$ <u>or</u> $t^2\left(\frac{9}{25}+\frac{12}{25}t+\frac{4}{25}t^2\right)$	M1	1.1b
	$=t^2\left(\frac{2}{5}t+\frac{3}{5}\right)^2$ *	A1* cso	2.1
		(2)	
(b)(i)	$G_W'(t)=2t\left(\frac{2}{5}t+\frac{3}{5}\right)^4+\left(\frac{2}{5}t+\frac{3}{5}\right)^5$	M1	2.1
	$\left[G_W'(1)=\right]$ **<u>3</u>**	A1	1.1b
(ii)	$G_W''(t)=2\left(\frac{2}{5}t+\frac{3}{5}\right)^4+\frac{16}{5}t\left(\frac{2}{5}t+\frac{3}{5}\right)^3+2\left(\frac{2}{5}t+\frac{3}{5}\right)^4$ oe	M1	2.1
	$G_W''(1)=\frac{36}{5}$	A1	1.1b
	$\text{Var}(W)="\frac{36}{5}"+"3"-("3")^2$	M1	2.1
	$=\frac{6}{5}$	A1	1.1b
		(6)	
(c)	$G_X(t)=t^2\left(\frac{2}{5}t+\frac{3}{5}\right)^2\times t\left(\frac{2}{5}t+\frac{3}{5}\right)^5$	M1	3.1a
	$=t^3\left(\frac{2}{5}t+\frac{3}{5}\right)^7$	A1	1.1b
		(2)	
(d)	$G_Y(t)=t^3\times(t^2)^3\times\left(\frac{2}{5}t^2+\frac{3}{5}\right)^7$	M1	3.1a
	$=t^9\left(\frac{2}{5}t^2+\frac{3}{5}\right)^7$	A1	1.1b
		(2)	
(e)	$P(Y=15)$ is coefficient of t^{15} ie $...+t^9\times{}^7C_3\left(\frac{2}{5}t^2\right)^3\left(\frac{3}{5}\right)^4+...$ <u>or</u> $P(X=6)$ need coefficient of t^6 i.e. $...+t^3\times{}^7C_3\left(\frac{2}{5}t\right)^3\left(\frac{3}{5}\right)^4+...$	M1	1.1b
	$\left[P(Y=15)=\right]\frac{22680}{78125}=\frac{4536}{15625}=0.290304$	A1	1.1b
		(2)	
			(14 marks)

Notes:		
(a)	**M1** **A1***	A correct un-simplified pgf based on $\sum t^v \mathrm{P}(V=v)$ cso must see an un-simplified version i.e. M1 scored and no incorrect working seen
(b) (i)	**M1** **A1**	Differentiating using the product rule to find $\mathrm{G}_W'(t)$ Allow un-simplified e.g. $5\times\frac{2}{5}t$ Need two terms added and at least one correct. If they expand we need 3 correct. 3 from a correct derivative
(ii)	**1st M1** **1st A1**	Attempt $\mathrm{G}_W''(t)$ ft their $\mathrm{G}_W'(t)$ [must be at least 2 terms or a product], one correct ft term, same rule for differentiating a product $\frac{36}{5}$ or 7.2 from a correct derivative
	2nd M1 **2nd A1**	$\mathrm{G}_W''(1)+\mathrm{G}_W'(1)-\left(\mathrm{G}_W'(1)\right)^2$ ft their $\mathrm{G}_W''(t)$ if different from $\mathrm{G}_W'(t)$ and $\mathrm{G}_W(t)$ **Dep on M3A2** $\frac{6}{5}$ or 1.2
(c)	**M1** **A1**	Realising the need to use $\mathrm{G}_X(t) = \mathrm{G}_V(t)\times\mathrm{G}_W(t)$ $t^3\left(\frac{2}{5}t+\frac{3}{5}\right)^7$
(d)	**M1** **A1**	Realising the need to multiply through by t^3 <u>or</u> substitute t^2 for t <u>or</u> sight of $t^3\mathrm{G}_X(t^2)$ $t^9\left(\frac{2}{5}t^2+\frac{3}{5}\right)^7$ oe Need not be in its simplest form
(e)	**M1** **A1**	Attempting to find correct coefficient of t^n <u>or</u> identify $Y = 2J + 9$ where $J \sim \mathrm{B}(7, 0.4)$ Need an expression can ft their $\mathrm{G}_Y(t)$ or $\mathrm{G}_X(t)$ of the form $t^n(at^m+b)^k$ Allow a statement that $\mathrm{P}(Y = 15) = 0$ if it follows from their pgf For a correct exact answer or allow awrt 0.2903 Allow 0.29 from correct expression

Alternative for (b)

(b)	$W = P+1$ where $P \sim \mathrm{B}(5,0.4)$ so Var (W) = Var(P)		
(i)	$\mathrm{G}_P'(t)=2\left(\frac{2}{5}t+\frac{3}{5}\right)^4$	M1	2.1
	$\mathrm{G}_W'(1)=2+1=3$	A1	1.1b
(ii)	$\mathrm{G}_P''(t)=\frac{16}{5}\left(\frac{2}{5}t+\frac{3}{5}\right)^3$; $\mathrm{G}_P''(1)=\frac{16}{5}$	M1; A1	2.1 1.1b
	$\mathrm{Var}(W)="\frac{16}{5}"+"2"-("2")^2$; $=\frac{6}{5}$	M1; A1	2.1 1.1b
SC	**MR** They use $\mathrm{G}_V(t)$ instead of $\mathrm{G}_W(t)$ Provided some correct differentiation seen: Award B1 for $\mathrm{E}(V) = \frac{14}{5}$ and B1 for $\mathrm{Var}(V) = \frac{12}{25}$ score as M0A1M0A0M0A1		

Question	Scheme	Marks	Aos
7(a)	$\overline{X} \sim \mathrm{N}(1000, 90)$ (May be implied by correct prob or z value seen) $\mathrm{P}(\overline{X} > 1020) = 0.0175\ldots$ or $z = 2.108$ $0.0175\ldots < 0.025$ or $z = 2.108\ldots > 1.96$ therefore reject H_0. There is evidence that the <u>mean weight</u> of the <u>flour</u> in a bag is <u>not 1000 g</u> **or** evidence of a <u>change</u> in <u>mean weight</u> of <u>flour</u> in a bag	M1 A1 M1 A1 cso **(4)**	3.3 3.4 1.1b 2.2b
(b)	$\left[\overline{Y} \sim \mathrm{N}\left(1000, \frac{900}{n}\right) \Rightarrow\right] \quad \frac{c-1000}{30/\sqrt{n}} = 1.6449$ $c = 1000 + \frac{49.347}{\sqrt{n}}$	M1 A1 **(2)**	3.4 1.1b
(c)	$\frac{"1000 + \frac{49.347}{\sqrt{n}}" - 1020}{30/\sqrt{n}} = -2.5758$ $\frac{126.621}{\sqrt{n}} = 20$ <u>or</u> $\frac{49.34...}{c-1000} = \frac{-77.274}{c-1020}$ (Allow 2sf accuracy) $n =$ **<u>40</u>** $c = 1007.8\ldots$ awrt **<u>1010</u>**	M1 A1ft dM1 A1 A1 **(5)**	3.4 1.1b 1.1b 2.1 1.1b
		(11 marks)	

Notes:

(a)	**1st M1**	Setting up the correct model. Normal with $\mu = 1000, \sigma^2 = 90$ or $\sigma = \sqrt{90}$ or awrt 9.49
	1st A1	Using the model to find the correct z value or $\mathrm{P}(\overline{X} > 1020) =$ awrt 0.0175 Allow CR $\overline{C}$ … 1018.59.. awrt 1019 [> is OK] Ignore lower CR provided < 1000
	2ndM1	Correct comparison <u>or</u> non-contextual conclusion. Allow comparison of 1020 with critical region. **Dep on** $\mathrm{P}(\overline{X} > 1020)$ M0 if there are contradictory statements.
	2ndA1	cso **dep on M1A1M1** for a correct conclusion in context with underlined words Do NOT accept "mean weight has <u>increased</u>"
(b)	**M1**	For Finding the CR using the Normal distribution. Condone $\sigma = \sqrt{\frac{30}{n}}$ to score M1 $\frac{c-1000}{30/\sqrt{n}} = z$ where $\lvert z \rvert > 1.5$ **Allow any inequality or = for M1 in (b) and M1 A1ft M1 in (c)**
	A1	A correct equation in the form $c =\ldots$ and for use of awrt 1.6449 (implied by awrt 49.3[4]) Condone $\overline{X}$ used for c (o.e.)
(c)	**1st M1**	Standardising using their c (letter or expression) and equating to z ($\lvert z \rvert > 2$) to form an equation in n or n and c. Can ft their σ **used** in (b) for M1A1ft here
	1stA1ft	Ft their "c" for a correct equation with -2.58 (or 1.64 or 1.65 used in (b))
	2nddM1	**Dependent 1st M1**. Isolating or eliminating either $\sqrt{n}$ or n <u>or</u> eliminating c leading to an equation for n or c
	2nd A1	For 40 (allow 41) Must be an integer. With correct working. e.g. Check correct σ has been used
	3rd A1	For awrt 1010 from correct working