Write your name here

Surname	Other names

Pearson
Edexcel GCE

Centre Number | Candidate Number

Statistics S1

Advanced/Advanced Subsidiary

Wednesday 15 June 2016 – Morning
Time: 1 hour 30 minutes

Paper Reference
6683/01

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

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 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 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 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

- 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.

1. A biologist is studying the behaviour of bees in a hive. Once a bee has located a source of food, it returns to the hive and performs a dance to indicate to the other bees how far away the source of the food is. The dance consists of a series of wiggles. The biologist records the distance, d metres, of the food source from the hive and the average number of wiggles, w, in the dance.

Distance, *d* m	30	50	80	100	150	400	500	650
Average number of wiggles, *w*	0.725	1.210	1.775	2.250	3.518	6.382	8.185	9.555

[You may use $\sum w = 33.6$ $\sum dw = 13833$ $S_{dd} = 394600$ $S_{ww} = 80.481$ (to 3 decimal places)]

(a) Show that $S_{dw} = 5601$.

(2)

(b) State, giving a reason, which is the response variable.

(1)

(c) Calculate the product moment correlation coefficient for these data.

(2)

(d) Calculate the equation of the regression line of w on d, giving your answer in the form $w = a + bd$.

(4)

A new source of food is located 350 m from the hive.

(e) (i) Use your regression equation to estimate the average number of wiggles in the corresponding dance.

(ii) Comment, giving a reason, on the reliability of your estimate.

(2)

(Total 11 marks)

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2. The discrete random variable X has the following probability distribution, where p and q are constants.

x	–2	–1	$\frac{1}{2}$	$\frac{3}{2}$	2
$P(X = x)$	p	q	0.2	0.3	p

(a) Write down an equation in p and q.

(1)

Given that $E(X) = 0.4$,

(b) find the value of q.

(3)

(c) Hence find the value of p.

(2)

Given also that $E(X^2) = 2.275$,

(d) find $Var(X)$.

(2)

Sarah and Rebecca play a game.

A computer selects a single value of X using the probability distribution above.

Sarah's score is given by the random variable $S = X$ and Rebecca's score is given by the random variable $R = \frac{1}{X}$.

(e) Find $E(R)$.

(3)

Sarah and Rebecca work out their scores and the person with the higher score is the winner. If the scores are the same, the game is a draw.

(f) Find the probability that

(i) Sarah is the winner,

(ii) Rebecca is the winner.

(4)

(Total 15 marks)

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3. Before going on holiday to *Seapron*, Tania records the weekly rainfall (x mm) at *Seapron* for 8 weeks during the summer. Her results are summarised as

$$\sum x = 86.8 \qquad \sum x^2 = 985.88$$

(a) Find the standard deviation, σ_x, for these data.

(3)

Tania also records the number of hours of sunshine (y hours) per week at *Seapron* for these 8 weeks and obtains the following

$$\bar{y} = 58 \qquad \sigma_y = 9.461 \text{ (correct to 4 significant figures)} \qquad \sum xy = 4900.5$$

(b) Show that $S_{yy} = 716$ (correct to 3 significant figures).

(1)

(c) Find S_{xy}.

(2)

(d) Calculate the product moment correlation coefficient, r, for these data.

(2)

During Tania's week-long holiday at *Seapron* there are 14 mm of rain and 70 hours of sunshine.

(e) State, giving a reason, what the effect of adding this information to the above data would be on the value of the product moment correlation coefficient.

(2)

(Total 10 marks)

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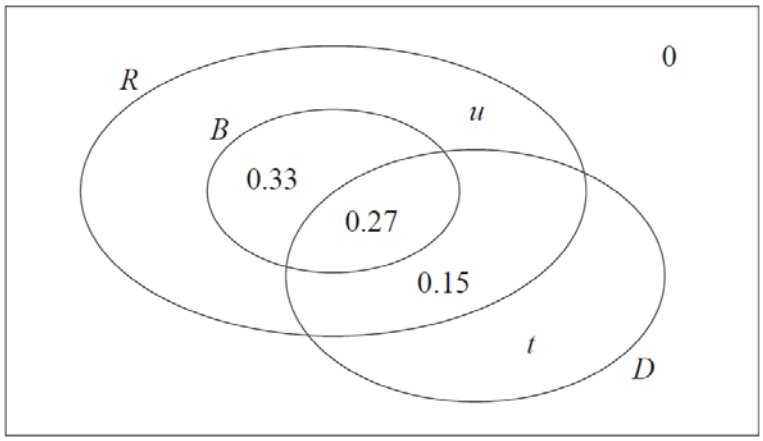
4. The Venn diagram shows the probabilities of customer bookings at Harry's hotel.

R is the event that a customer books a room

B is the event that a customer books breakfast

D is the event that a customer books dinner

u and t are probabilities.



(a) Write down the probability that a customer books breakfast but does not book a room.

(1)

Given that the events B and D are independent,

(b) find the value of t.

(4)

(c) Hence find the value of u.

(2)

(d) Find

(i) $P(D|R \cap B)$,

(ii) $P(D|R \cap B')$.

(4)

A coach load of 77 customers arrive at Harry's hotel.

Of these 77 customers

40 have booked a room and breakfast

37 have booked a room without breakfast

(e) Estimate how many of these 77 customers will book dinner.

(Total 13 marks)

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5. A midwife records the weights, in kg, of a sample of 50 babies born at a hospital. Her results are given in the table below.

Weight (w kg)	**Frequency (f)**	**Weight midpoint (x)**
$0 \leq w < 2$	1	1
$2 \leq w < 3$	8	2.5
$3 \leq w < 3.5$	17	3.25
$3.5 \leq w < 4$	17	3.75
$4 \leq w < 5$	7	4.5

[You may use $\sum fx^2 = 611.375$]

A histogram has been drawn to represent these data.

The bar representing the weight $2 \leq w < 3$ has a width of 1 cm and a height of 4 cm.

(a) Calculate the width and height of the bar representing a weight of $3 \leq w < 3.5$.

(3)

(b) Use linear interpolation to estimate the median weight of these babies.

(2)

(c) (i) Show that an estimate of the mean weight of these babies is 3.43 kg.

(ii) Find an estimate of the standard deviation of the weights of these babies.

(3)

Shyam decides to model the weights of babies born at the hospital, by the random variable W, where $W \sim N(3.43, 0.65^2)$.

(d) Find $P(W < 3)$.

(3)

(e) With reference to your answers to (b), (c)(i) and (d) comment on Shyam's decision.

(3)

A newborn baby weighing 3.43 kg is born at the hospital.

(f) Without carrying out any further calculations, state, giving a reason, what effect the addition of this newborn baby to the sample would have on your estimate of the

(i) mean,

(ii) standard deviation.

(3)

(Total 17 marks)

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6. The time, in minutes, taken by men to run a marathon is modelled by a normal distribution with mean 240 minutes and standard deviation 40 minutes.

(*a*) Find the proportion of men that take longer than 300 minutes to run a marathon.

(3)

Nathaniel is preparing to run a marathon. He aims to finish in the first 20% of male runners.

(*b*) Using the above model estimate the longest time that Nathaniel can take to run the marathon and achieve his aim.

(3)

The time, W minutes, taken by women to run a marathon is modelled by a normal distribution with mean μ minutes.

Given that $P(W < \mu + 30) = 0.82$,

(*c*) find $P(W < \mu - 30 \mid W < \mu)$.

(3)

(Total 9 marks)

TOTAL FOR PAPER: 75 MARKS

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June 2016
6683 STATISTICS 1
Mark Scheme

Question Number	Scheme	Marks
1.(a)	$S_{dw} = 13833 - \frac{"1960" \times 33.6}{8}$ or $13833 - \frac{65856}{8}$ (But 13833 – 8232 is M0) = **5601** **(*)**	M1 A1 cso (2)
(b)	*w*, since the number of wiggles depends on the distance or *w* depends on *d*	B1 (1)
(c)	$r = \frac{5601}{\sqrt{394600 \times 80.481}}$, $= 0.99389\ldots$ **awrt 0.994**	M1,A1 (2)
(d)	$b = \frac{5601}{394600}$, = 0.014194…. (awrt 0.014)	M1, A1
	$a = \frac{33.6}{8} - "0.01419..." \times \frac{"1960"}{8} = 4.2 - "0.01419..." \times 245$ [= 0.72244..]	M1
	$w = 0.722 + 0.0142d$	A1 (4)
(e)	(i) [0.722 + 0.0142×350 =] **awrt: 5.7** or **5.6** (ii) Reliable since 350 m is in the range of the data	B1 B1 (2) **[11 marks]**

	Notes
(a)	M1 for clear attempt to find Σd and use in a correct formula. Accept $1300 < \Sigma d < 2500$ For the M1 we can condone a single slip e.g. using 1383 instead of 13833 etc A1cso for correct Σd and 5601 only. Must see the formula and so have scored M1
(b)	B1 Must select *w* (or wiggles) and reason based on the idea that *w* is dependent on *d* Allow *w* "changes according to"/ "is determined/affected by" Must mention *w* and *d* B0 for "*w* is measured" or "*d* is explanatory/indep't" or "*w* can't be controlled" or "*w* responds to *d*"
(c)	M1 for a correct expression (Allow ft of their incorrect S_{dw}) A1 for awrt 0.994 (Answer only 2/2) [Answer only of 0.99 scores M1A0]
(d)	1st M1 for a correct expression for *b*. (Allow ft of their incorrect S_{dw}) 1st A1 for awrt 0.014 No fractions. [Answer only 2/2] Can be given at final equation. [Must come from correct formula not gradient of line from e.g. (650, 9.555) to (30, 0.725)] 2nd M1 for a correct method for *a*. Follow through their value of *b* and their Σd 2nd A1 for a correct equation for *w* and *d* with *a* = awrt 0.722 and *b* = awrt0.0142 No fractions Equation in *x* and *y* is A0 Answer only 4/4
(e)	1st B1 for awrt 5.7 or awrt 5.6 2nd B1 for a reason citing 350 (m) or mentioning *d* is in the range of the data and stating reliable. Allow "Interpolation (or not extrapolation) therefore reliable". Saying "5.7 (or *w* or just "it") is in the range" is B0 "accurate" instead of "reliable" is B0 "strong correlation" (without mention of interpolation o.e.) is B0 Apply ISW if a correct comment is seen.

Question Number	Scheme	Marks
2.(a)	$p + q + 0.2 + 0.3 + p = 1$ or $2p + q = 0.5$ (o.e.)	B1 (1)
(b)	[E(X) =] $-2p - q + \frac{1}{2}\times 0.2 + \frac{3}{2}\times 0.3 + 2p$ [= 0.4] or $-q + 0.1 + 0.45$ [= 0.4]	M1A1
	$\underline{\boldsymbol{q = 0.15}}$	A1 (3)
(c)	$2p$ + "0.15" = 0.5 (o.e)	M1
	$\underline{\boldsymbol{p = 0.175}}$	A1 (2)
(d)	[Var(X) =] $2.275 - (0.4)^2$	M1
	= $\underline{\mathbf{2.115}}$ (Accept 2.12)	A1 (2)
(e)	r | $-\frac{1}{2}$ | -1 | 2 | $\frac{2}{3}$ | $\frac{1}{2}$ P($R = r$) | p | q | 0.2 | 0.3 | p	M1
	E(R) = $-\frac{1}{2}p - q + 0.4 + 0.2 + \frac{1}{2}p$	dM1
	= $0.6 - q$ = $\underline{\mathbf{0.45}}$ (or $\frac{9}{20}$)	A1ft (3)
(f)(i)	$S > R$ when x = 1.5 and 2	M1
	P(Sarah wins) = $0.3 + p$ = $\underline{\mathbf{0.475}}$ (or $\frac{19}{40}$)	A1ft
(ii)	$R > S$ when $x = -2$ and $\frac{1}{2}$ or $r = -\frac{1}{2}$ and 2	M1
	P(Rebecca wins) = $0.2 + p$ = $\underline{\mathbf{0.375}}$ (or $\frac{15}{40}$)	A1ft (4)
		[15 marks]

	Notes
(a)	B1 for any correct equation based on sum of probs. = 1
	Correct answer only in (b), (c), (d), (e) or (f) scores full marks for that part.
(b)	M1 for an attempt at an expression based on E(X). At most 2 errors or omissions.
	1st A1 for a correct equation [May be implied by a correct answer]
	2nd A1 for q = 0.15 or exact equivalent e.g. $\frac{6}{40}$
(c)	M1 for correct equation or using their equation from (a) with their q, provided $q \in$ [0,1]
	A1 for p = 0.175 or exact equivalent e.g. $\frac{7}{40}$
(d)	M1 for a correct numerical expression but M0 if followed by division by k (e.g. k = 5)
	A1 for 2.115 or accept awrt 2.12 (also accept exact equivalent e.g. $\frac{423}{200}$)
(e)	1st M1 for correct values for R, allow 1 error, and allow unsimplified. Condone no label if not used as probabilities. If seen in table on QP allow, but must be labelled. Just writing the sum Σr is M0 but adding later can score 1st M1
	2nd dM1 dependent on 1st M1 for an attempt at an expression based on E(R), ft p and q, (if probabilities) ft their r values. At least 3 correct (or correct ft) products seen.
	A1ft for 0.45 or (0.6 – their q) provided q is a probability
	Answers for (f) must be clearly labelled or take 1st as (i) and 2nd as (ii)
(f)(i)	M1 for identifying the correct values of X
	A1ft for 0.475 or 0.3 + their p , provided answer is a probability
(ii)	M1 for identifying the correct values of X or R
	A1ft for 0.375 or 0.2 + their p or 1 – their 0.475 – their q, provided ans. is a probability
SC1 X_1,X_2	They use two values of X: (i) for P($S > R$) = 0.445 (B1) (ii) for P($R > S$) = 0.4625 (B1). No ft
SC2 swap	Answers wrong way round: (i) P($S > R$) = 0.375 and (ii) P($R > S$) = 0.475 (B1) No ft
Epen	**On epen record SC1 as: (i) M0A1 (ii) M0A1 and SC2 as M0A0M0A1**

Question Number	Scheme	Marks
3 .(a)	$[\sigma_x^{\,2} =]\ \dfrac{985.88}{8} - \left(\dfrac{86.8}{8}\right)^2 = \dfrac{985.88}{8} - 10.85^2$	M1
	$\sigma_x = \sqrt{\dfrac{985.88}{8} - \left(\dfrac{86.8}{8}\right)^2} = \sqrt{123.235 - 117.7225} = \sqrt{5.5125}$ or $\sqrt{\dfrac{44.1}{8}}$	A1
	$= 2.3478\ldots$ = awrt **2.35**	A1
		(3)
(b)	$S_{yy} = 8 \times \sigma_y^{\,2}$ = 716 (3 sf) but may see	
	$1136.584 - \dfrac{58^2}{8}$ or $27628(.084168) - \dfrac{464^2}{8}$ or 716.08... (= 716 to 3 sf) **(*)**	B1cso
		(1)
(c)	$S_{xy} = 4900.5 - 58 \times 86.8$ or $4900.5 - \dfrac{86.8 \times 464}{8}$	M1
	$= -$**133.9** (Allow -134)	A1
		(2)
(d)	$r = \dfrac{-133.9/8}{\sigma_x \times \sigma_y}$ or $\dfrac{-133.9}{\sqrt{44.1 \times 716}}$	M1
	= awrt $-$**0.753** or $-$**0.754**	A1
		(2)
(e)	$r < 0$ means high sunshine and low rain; this is high sunshine high rain	B1
	[this is not in keeping with the trend so] r is closer to 0 or $\lvert r \rvert$ decreases	B1
		(2)
		[10 marks]

	Notes
(a)	M1 for a correct expr' for st. dev or variance (ignore label)[may be implied by 2.35 or 5.5125] 1st A1 for a correct expression for st. dev (must have square root) can ignore label 2nd A1 for awrt 2.35 (allow $s = 2.5099\ldots$ or awrt 2.51). If they have $\sigma^2 = 2.35$ score A0 but condone no label
(b)	B1cso for a correct expression or sight of at least 716.08… (NB limits: 716.00~716.16) Do not allow verification. Beware circular arguments: $716 \rightarrow \Sigma y^2 \rightarrow$ expr' $\rightarrow 716$
(c)	M1 for a correct expression for S_{xy} (NB $\Sigma y = 464$) A1 for -133.9 or awrt -134 [No fractions] (Answer only 2/2)
(d)	M1 for a correct expression for r (ft their values for S_{xy} and σ_x or S_{xx})[Allow ft of S_{yy}] A1 for awrt -0.753 or -0.754 (Answer only 2/2)
(e)	**If they do not have an answer to (d) or their value of r is > 0 or $\lvert r \rvert$ > 1 score B0B0 here** 1st B1 for a suitable reason contradicting $r < 0$ e.g. new value is not in keeping with trend or both $14 > \bar{x}$ and $70 > \bar{y}$ or saying both above average. Allow for $-0.48 <$ new $r < -0.47$ 2nd B1 for a correct statement about r getting closer to zero e.g. $\lvert r \rvert$ decreases A comment that r decreases or r is smaller or r is "less negative" is B0 "r increases" is B0 unless they also say that it gets closer to 0

Question Number	Scheme	Marks
4.(a)	[$P(B \cap R') =$] **0**	B1 (1)
(b)	$P(B) = 0.27+0.33 = 0.6$, $P(D) = 0.27 + 0.15 + t$, $P(B \cap D) = 0.27$	M1
	[$P(B) \times P(D) = P(B \cap D)$ gives] $0.6 \times (0.42 + t) = 0.27$	M1
	$0.42 + t = \frac{0.27}{0.6}$ or $0.6t = 0.018$	A1
	$t =$ **0.03**	A1 (4)
(c)	[$u =$] $1-(0.6+0.15+t)$	M1
	$u =$ **0.22**	A1ft (2)
(d)(i)	$\left[\frac{P(D \cap R \cap B)}{P(R \cap B)} =\right] = \frac{0.27}{0.27+0.33}$ or $P(D \mid R \cap B) = P(D \mid B) = P(D)$	M1
	= **0.45**	A1
(ii)	$\left[\frac{P(D \cap [R \cap B'])}{P(R \cap B')} =\right] = \frac{0.15}{0.15+u}$	M1
	$= \frac{15}{37}$	A1 (4)
(e)	$40 \times$"0.45" and $37 \times$"$\frac{15}{37}$"	M1
	= **33**	A1 (2) **[13 marks]**

	Notes
(b)	1st M1 for attempting 3 suitable probabilities, one involving t (at least 2 correct) e.g. sight of 0.6, 0.27, 0.42 + t correctly labelled in terms of B,D,R or in a correct equation. May see e.g. $P(B\|D) = \frac{0.27}{0.42+t}$ 2nd M1 for using the independence to form a linear equation in t. ft their probs if stated. 1st A1 for solving leading to a correct equation as far as $p + t = q$ or $pt = q$ 2nd A1 for 0.03 or exact equivalent
(c)	M1 for a correct expression for u . Allow their t or just letter t in a correct expression A1ft for 0.22 (or exact equivalent) or ft their t. i.e. $u = 0.25 - t$ provided u & t are probs Can score M1A1ft provided their u + their t = 0.25 where u and t are both in [0, 1]
(d)(i)	M1 for a correct numerical ratio of probabilities A1 for 0.45 or exact equivalent (Answer only 2/2)
(ii)	M1 for a correct numerical ratio of probabilities, ft their u, provided u is a probability A1 for $\frac{15}{37}$ or $0.\dot{4}0\dot{5}$ or allow awrt 0.41 following a correct expression (Ans only 2/2)
(e)	M1 for a correct method for both 18 and 15 ft their 0.45 and their $\frac{15}{37}$ provided both in [0,1] NB $P(D) \times 77$ is M0 A1 for 33 only NB $\frac{27}{33} \times 40 = 32.7\ldots$ which rounds to 33 but scores M0A0. (**Ans only send to review**)

Question Number	Scheme	Marks
5.(a)	Width = **0.5** (cm) e.g 4 [cm^2] represents 8 babies or frequency densities are 8 and 34 Height = **17** (cm)	B1 M1 A1 (3)
(b)	$[Q_2 =]$ $\{3\}+\frac{(25-9)}{(26-9)}\times 0.5$, or $\{3.5\}-\frac{(25-24)}{(41-24)}\times 0.5$ = awrt **3.47** (allow $\frac{59}{17}$)	M1, A1 (2)
(c)(i)	$\sum fx = 1\times 1+2.5\times 8+3.25\times 17+3.75\times 17+4.5\times 7 = 171.5$, $\bar{x}=\frac{171.5}{50}=(3.43)$ **(*)**	B1cso
(ii)	$\sqrt{\frac{611.375}{50}-3.43^2}$,= 0.680147… = awrt **0.680** (Accept 0.68)	M1, A1 (3)
(d)	[P($W<3$) = $P\left(Z<\frac{-0.43}{0.65}\right)$] = P($Z<-0.6615..$) = 1 – 0.7454 (tables) = 0.2546 awrt **0.254~0.255**	M1 M1 A1 (3)
(e)	(b) and (c)(i) mean ≠ med or skew or mean~ median or no skew **and** comment (d) = 0.254 or 0.255 compare data = 0.18 (or 12.7 compared with 9) 0.18 different from 0.25 so normal not good or 0.18 similar to 0.25 so normal is OK	B1 B1 dB1 (3)
(f)(i) **(ii)**	No change in mean (since weight is the same) s.d. will decrease (Extra value is at "centre" so data more concentrated) Both statements correct and correct reasons for each	B1 B1 dB1 (3) **[17 marks]**

	Notes
(a)	M1 for clear representation of area with frequency or height × width = 8.5 A1 for 17 (cm) [Must be clear it is height not frequency] (Ans only must satisfy $h\times w=8.5$)
(b)	M1 for $\frac{16}{17}\times 0.5$ or if using $n+1$ for $\frac{16.5}{17}\times 0.5$ May see $-\frac{1}{17}\times 0.5$ if working down A1 for awrt 3.47 (or $\frac{59}{17}$) [check from correct working] or (if using $(n+1)$ for 3.485 or awrt 3.49)
(c)(i)	B1cso for Σfx (at least 3 correct & no incorrect products seen) and correct $\frac{\sum fx}{50}$ or $\frac{171.5}{50}$
(ii)	M1 for a correct expression including square root. Must use 3.43 no ft A1 for awrt 0.680 (accept 0.68). Allow use of s = awrt 0.687 (Ans only 2/2)
(d)	1st M1 for an attempt to standardise with 3, 3.43 and 0.65. Allow ± and also use of their sd 2nd M1 for $1-p$ where $0.74<p<0.75$ NB calculator gives 0.7458665… A1 for awrt 0.254 or 0.255
(e)	1st B1 for a statement about mean/median **and** compatible comment about normal 2nd B1 for statement comparing their (d) with data (sight of 0.18 or 12.7 and 9 required) 3rd dB1 dep on 2nd B1 for conclusion about normal compatible with 2nd statement
(f)(i) **(ii)**	1st B1 for no change in mean {send a correct argument for decrease to review} 2nd B1 for s.d. decreases 3rd dB1 dep on 1st and 2nd Bs for a correct reason for both mean and sd e.g. "new mean the same so within 1 s.d. of old mean"

Question Number	Scheme	Marks
6.(a)	[$T \sim N(240, 40^2)$…require $P(T > 300)$]	
	$P\left(Z > \frac{300-240}{40}\right)$	M1
	$= 1 - P(Z < 1.5)$ or $1 - 0.9332$	M1
	= awrt **<u>0.0668</u>** or 6.68%	A1
		(3)
(b)	$\left[P(T < n) = 0.20 \Rightarrow\right]$ $\frac{n-240}{40} = -0.8416$	M1 B1
	n = awrt **<u>206</u>** minutes	A1
		(3)
(c)	$[P(W < \mu - 30 \mid W < \mu) =]$ $\frac{P(W < \mu - 30)}{P(W < \mu)}$	M1
	$= \frac{1-0.82}{0.50}$	A1
	= **<u>0.36</u>**	A1cao
		(3)
		[9 marks]

	Notes
(a)	1st M1 for standardising with 300, 240 and 40. May be implied by use of 1.5 Allow <u>±</u> 2nd M1 for 1 – P(*Z* < "1.5") i.e. a correct method for finding P(*Z* > "1.5") e.g. $1 - p$ where $0.5 < p < 0.99$ A1 for awrt 0.0668 (Answer only 3/3)
(b)	M1 for an attempt to standardise with 240, 40 and *n* and set = <u>±</u> *z* ($0.8 < \|z\| < 0.9$) B1 for *z* = <u>±</u> 0.8416 (or better) <u>used</u> as a *z* value. Do not allow for 1 – 0.8416 Calc gives 0.8416212…[**May be implied by awrt 206.34**, give B1 as well as A1 if seen] A1 for awrt 206 (can be scored for using a *z* value of 0.84 or even 0.85) Must follow from correct working but a range of possible *z* values are OK
Ans only	If answer is awrt 206 score M1B0A1 (unless of course z = 0.8416 seen) but awrt 206.34 scores 3/3
(c)	M1 for the correct ratio expression (<u>Not</u> $P(\left[W < 30 - \mu\right] \cap \left[W < \mu\right])$ on numerator) Condone use of *Z* instead of *W* <u>only if</u> they later get a correct numerical ratio otherwise M0 However they may write $P\left(Z < \frac{-30}{\sigma}\right)$ etc which is of course fine 1st A1 for a correct numerical ratio
Use tables	May see use of *z* = 0.92 or better (calc: 0.9153650…) or σ = 32.6~32.8 allow:
ALT	1st M1 for $\frac{P(Z < -0.92)}{P(Z < 0)}$ and 1st A1 for $\frac{1-0.8212}{0.5}$ or $\frac{0.1788}{0.5}$
	2nd A1 for 0.36 or an exact equivalent e.g. $\frac{9}{25}$ (Answer only M1A1A0) The final answer of 0.36 <u>must</u> come from exact values; 0.36 rounded from 0.3576 etc is A0