A-LEVEL
Mathematics

Statistics 1A – MS1A/W
Mark scheme

6360
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Version/Stage: Final

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Key to mark scheme abbreviations

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation
√or ft or F	follow through from previous incorrect result
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Q	Solution	Marks	Total	Comments
1	**No MR or MC in this question**			**Ignore units throughout this question**
(a)	Mean = **<u>70.4</u>**	B2		CAO
	Mean = **<u>70.1 to 70.7</u>**	(B1)		AWFW; but exclude 70.5 unless with a **correct method** (see **Note 2**)
	SD = **<u>2.03 or 2.06</u>**	B2		Either AWRT (2.0312 or 2.0608)
	SD = **<u>2 to 2.1</u>**	(B1)	**4**	AWFW
Notes	**1** $\sum fx = 2464$ and $\sum fx^2 = 173610$ **2** Using only x-values gives Mean = 70.5 and SD = 2.87 or 3.03 $\Rightarrow$ B0 B0 **3** Using only f-values gives Mean = 3.5 and SD = 2.33 or 2.46 $\Rightarrow$ B0 B0 **4** If, and only if, B0 B0, then award M1 for **seen** attempt at $\sum fx \div 35$ or for 2464÷35			
(b)	Henrietta keeps $(x - 60)$ so:			
	Mean = **<u>10.4</u>**	BF1		FT on any mean > 60 from (a)(iii) but must **subtract 60** **and** state **numerical** value > 0
	SD = **<u>2.03 or 2.06</u>**	BF1	**2**	FT on any SD > 0 from (a)(iii) but must state **unchanged numerical** value > 0
Notes	**1** Mean is "60 fewer" than previously/in (a) (OE) $\Rightarrow$ BF0 **2** SD is "exactly same" as previously/in (a) (OE) $\Rightarrow$ BF0 **3** If mean and SD calculated using $(x-60)$, $\sum f(x-60) = 364$ and $\sum f(x-60)^2 = 3930$, then, to score marks, the answers must be 10.4 (CAO) and 2.03 (AWRT) or 2.06 (AWRT)			
		Total	**6**	

Q	Solution	Marks	Total	Comments
2	**No MR or MC in this question**			**Accept %age equivalents in (a)(i) to (iii)**
(a)	Volume, $X \sim N(340,\ 3.2^2)$			
(i)	$P(X > 345) = P\left(Z < \frac{345-340}{3.2}\right)$	M1		Standardising 345 with 340 and 3.2 but allow $(340 - 345)$
	$= P(Z > \underline{\mathbf{1.56}})$	A1		AWRT; ignore sign (1.5625)
	$= 1 - 0.94091 = \underline{\mathbf{0.059}}$	A1	**(3)**	AWRT (0.05909)
(ii)	$P(X < 333) = P(Z < -2.1875)$ $= 1 - P(Z < 2.1875)$	M1		**Correct** area change; **neither** 2.1875 or correct standardising are required Can be implied by **final answer < 0.5**
	$= 1 - 0.98565 = \underline{\mathbf{0.014\ to\ 0.015}}$	A1	**(2)**	AWFW (0.01435)
(iii)	$P(333 < X < 345) = P(Z < 1) - P(Z < -1.5)$ $= [1 - (i)] - (ii)$ **or** $[1 - (ii)] - (i)$ **or** $1 - (i) - (ii)$	M1		OE; any **correct** difference in areas that results in **answer > 0** Can be implied by **correct** answer but not necessarily if answers to (i) &/or (ii) are (1 – correct answer)
	$= \underline{\mathbf{0.926\ to\ 0.927}}$	A1	**(2)**	AWFW (0.92656)
(iv)	$P(X = 340) = \underline{\mathbf{0\ or\ zero\ or\ nought\ or\ 0\%}}$	B1	**(1)**	CAO; accept nothing else but ignore additional words providing that they are not contradictory (eg impossible so = 0)
Note	**1** $P(X = 340) = P(Z = 0) \Rightarrow$ B0 unless followed by 0 OE			
			8	
(b) **(i)**	By **symmetry** **or** because $\mu = \frac{330+345}{2}$	B1	**1**	OE
(ii)	$0.975 \Rightarrow z = \underline{\mathbf{1.96}}$	B1		AWRT; ignore sign (1.9600)
	$\left(\frac{345-337.5}{\sigma}\right) = 1.96$ **or** $\left(\frac{330-337.5}{\sigma}\right) = -1.96$	M1		Standardising 345 or 330 with 337.5 and σ or s; **and** equating to 1.96 (*ignore sign*) Can be implied by **correct** answer
	$\sigma = \underline{\mathbf{3.8}}$	A1	**3**	AWRT (3.82653) ***Must be consistent signs throughout***
		Total	**12**	

Q	Solution	Marks	Total	Comments
3	**No MR or MC in this question except as indicated in the following Notes**			
Notes for part (a)	**1** If **correct** fraction, percentage or ratio is followed by incorrect decimal, then apply ISW but apply penalties as in Notes 2 to 5 **2** At least one **decimal answer** given to more than 3 dp (including 0.0320) **or** at least one **recurring decimal answer** (eg $0.29\dot{3}$ or $0.2\dot{9}\dot{0}$) are penalised by **1 mark** **3** At least one **fractional** answer (eg 22/75) is penalised by **1 mark** **4** At least one **percentage** answer (eg 29.3) is penalised by **1 mark** **5** At least one **ratio** answer (eg 22:75) is penalised by **2 marks** Mark answers as below and then apply MR–1 or MR–2 as appropriate (if available) at end of question before totalling marks			
(a)(i)	P(FH) = **220/750 = 22/75 = 0.293**	B1	**(1)**	CAO/AWRT (0.29333)
(ii)	P(AH ∩ BE) = **24/750 = 8/250 = 4/125 = 0.032**	B1	**(1)**	CAO
(iii)	P(AH ∪ BE but not both) = $\frac{110+215-2\times24}{750}$	M1		OE Can be implied by **correct answer**
	= **277/750 = 0.369**	A1	**(2)**	CAO/AWRT (0.36933)
SC	Award B1 for 301/750 **or** 0.401(33)			
(iv)	P(GE | FH) = $\frac{64}{750}\Big/\frac{220}{750}$ =	M1		OE Can be implied by **correct answer**
	64/220 = 32/110 = 16/55 = 0.291	A1	**(2)**	CAO/AWRT (0.29091)
			6	
(b)	P((DH ∩ BE) ∩ (DH ∩ BE) ∩ (MH ∩ GE)) = $\frac{92}{750}\times\frac{91}{749}\times\frac{55}{748}$	M1 M1		Correct 3 values multiplied in numerator Correct 3 values multiplied in denominator $0.123 \times 0.121 \times 0.074$ (all AWRT) ⇒ M1 M1 (OE products)
	Multiplied by 3	m1		Dependent on at least one M1 scored
	or			
	$\binom{92}{2}\binom{55}{1}\div\binom{750}{3}$	(M1 M1) (M1)		Numerator Denominator
	= (299/90950) = **0.00328 to 0.00329**	A1	**4**	AWFW (0.00328752)
Notes	**1** Incorrect answer with no working ⇒ 0 marks **2** The **3 correct fractions or decimals** identified but not multiplied (eg added) ⇒ M1 M0 m0 A0 **3** The **3 correct fractions or decimals** identified along with 0.0011 (AWRT) ⇒ M1 M1 m0 A0 **4** Do **not** penalise a **correct answer** given to more than 3sf **5** Answer given as 3.28×10^{-3} to 3.29×10^{-3} ⇒ M1 M1 m1 A1			
		Total	**10**	

Q	Solution	Marks	Total	Comments
4	**No MR or MC in this question**			
(a) (i)	r_{uv} = **0.915** = **0.9 to 0.92** = **0.8 to 0.99**	B3 (B2) (B1)		AWRT (0.91468) AWFW AWFW
	Attempt at $\sum u$ $\sum u^2$ $\sum v$ $\sum v^2$ & $\sum uv$ **or** Attempt at S_{uu} S_{vv} & S_{uv}	(M1)		81.58 808.2288 70.11 632.3553 & **701.6158** (all 5 attempted) 142.69916 140.81409 & **129.65842** (all 3 attempted)
	Attempt at substitution into **correct** corresponding formula for r_{uv} r_{uv} = **0.915**	(m1) (A1)	**3**	AWRT
(ii)	r_{xy} = **0.915**	BF1		F on (i) providing **$-1 < r_{uv} < +1$** Value quoted must be 0.915(AWRT) **or** identical to answer in (i)
Notes	**1** Award on value only; ignore any explanation or working **2** $r_{xy} = r_{uv}$ with no value stated $\Rightarrow$ B0 **3** Calculating r_{xy} using values of x & y $\Rightarrow$ B1 only if r_{xy} = 0.915 (AWRT)			
	r is **not affected** by **linear scaling** **or** **Scaling/coding/transformation/change/ conversion** to u and v is **linear**	Bdep1		OE; accept "Formula" or "It" for r but reference to "**linear**" is necessary Dependent on BF1 OE; but reference to "**linear**" is necessary
Notes	**1** All values changed using (same) **linear** scale/formula $\Rightarrow$ B1 **2** All values changed using (same) scale/formula/–100 $\Rightarrow$ B0 **3** **Linear** formula has no effect on r $\Rightarrow$ B1 **4** Formula has no effect on r $\Rightarrow$ B0 **5** r is not affected by units (June 2013!) $\Rightarrow$ B0			
			2	
(b)	(Very) **strong positive** (linear) **correlation**	Bdep1		Dependent on **$0.8 \le (r_{xy}$ or $r_{uv}) \le 0.99$** OE; must **qualify strength** and **state positive**
Notes	**1** Only accept phrase stated; ignore additional comments unless contradictory **2** Use of: "quite/fairly/extremely/relatively strong or high or big or good or moderate or medium or average" $\Rightarrow$ Bdep0 **3** Accept "relationship/association/link" but not "trend" instead of "correlation"			
	between (average) **qualifying speed** and (average) **race speed**	B1	**2**	Context; providing **$-1 < (r_{xy}$ or $r_{uv}) < 1$**
Notes	**1** Accept "qualifying mph" and "race mph" but **not** "mph" without identification **2** Accept "fastest/qualifying lap" and "three/ race laps"			
		Total	**7**	

Q	Solution	Marks	Total	Comments
5	**No MR or MC in this question**			**Accept percentage equivalents in (a)**
(a) **(i)**	$p(0) = \underline{\mathbf{0.18}}$	B1		CAO; can be implied from working or **correct answer**
	$\mathrm{P(H=3)} = \binom{30}{3}(p)^3(1-p)^{27}$	M1		Correct expression using p = **0.18**, 0.47, 0.25 **or** 0.10 Can be implied by **correct answer** Ignore extra terms
	$= \underline{\mathbf{0.111 \text{ to } 0.112}}$	A1	**3**	AWFW (0.11151)
(ii)	$p(\geq 3) = \underline{\mathbf{0.1}}$	B1		CAO; can be implied from working or **correct answer**
	$\mathrm{P(H \leq 5)} = \underline{\mathbf{0.926 \text{ to } 0.927}}$	B1	**2**	AWFW (0.9268)
(iii)	$p(\geq 2) = \underline{\mathbf{0.35}}$	B1		CAO; can be implied from 0.5078 or 0.3575 (accept 3dp rounding) or **correct answer**
	$\mathrm{P(H > 10)} = \underline{\mathbf{1 - (0.5078 \text{ or } 0.3575)}}$	M1		Requires "1 – either probability" Accept 3 dp rounding Can be implied by (0.492) but **not** by (0.642 to 0.643)
	$= \underline{\mathbf{0.492}}$	A1	**3**	AWRT (0.4922)
SC	For calculation of individual terms: award B1 B2 for 0.492 (AWRT); award B1 for 0.642 to 0.643 (AWFW)			
(iv)	$\underline{p(=2) = 0.25}$			
	$\mathrm{P(5 < H < 10)} =$ **0.8034 or 0.8943** (p_1)	M1		Accept 3 dp rounding Can be implied by **correct answer**
	MINUS 0.2026 or 0.0979 (p_2)	M1		Accept 3 dp rounding Can be implied by **correct answer**
	$= \underline{\mathbf{0.6 \text{ to } 0.601}}$	A1	**3**	AWFW (0.6008)
Notes	**1 First M1** is for $(+p_1)$ in calculation **2 Second M1** is for $(-p_2)$ in calculation **3** $(1-p_2) - (1-p_1) \Rightarrow$ M1 M1 (A1) **4** B(30, 0.25) probabilities shown for **at least 3** values within $4 \leq X \leq 10 \Rightarrow$ M2 May be implied by a **correct answer** Ans = **0.6 to 0.601** $\Rightarrow$ A1			

x	4	5	6	7	8	9	10
$\mathbf{P(X=x)}$	0.0605	0.1047	0.1455	0.1662	0.1593	0.1298	0.0909

	Part (a)		**11**	

Q	Solution	Marks	Total	Comments
5	**No MR or MC in this question**			
	Part (a)		**(11)**	
(b) **(i)**	Mean $\left(\mu \text{ or } \bar{x}\right)$ = **<u>9.4</u>**	B1		CAO B(20, 0.47)
	Variance $\left(\sigma^2 \text{ or } s^2\right)$ = **<u>4.98 to 5</u>**	B1	**2**	AWFW (4.982)
Notes	**1** If answers are not identified, then assume that order of values is mean, variance **2** If 4.98 to 5 labelled as SD (σ or s) $\Rightarrow$ B0			
(ii)	Mean or 6 is **less than/different to** 9.4 Variance or 21.2 is **greater than/different to** 4.98 to 5	Bdep1		**Both** OE Dependent on B1 B1 in (i) Must be **2 clear correct** comparisons
	Agree with claim **or** no reason to doubt claim	Bdep1	**2**	Dependent on Bdep1
Note	**1** Statements such as "Claim likely/reasonable/supported/correct/true/possible/valid" $\Rightarrow$ Bdep1 providing previous Bdep1			
	Part (b)		**(4)**	
		Total	**15**	

Q	Solution	Marks	Total	Comments
6	**No MR or MC in this question**			
(a)				
(i)	Attempt at $\bar{v} - n\sigma = 118 - 65n < 0$	M1		Allow 1.82, 2, 3 or 4 for n with a **correct numerical answer**
	and			
	negative usage/volume is impossible	A1		OE; must be in context Negative value is impossible ⇒ A0
			2	
Notes	**1** $n = 1.82 \Rightarrow$ **≈0**; $n = 2 \Rightarrow$ **–12**; $n = 3 \Rightarrow$ **–77**; $n = 4 \Rightarrow$ **–142** **2** Attempt at $P(V < 0) = P\left(Z < \frac{0-118}{65}\right)$ or $\left(z = \pm\frac{0-118}{65}\right)$ ⇒ M1 (Standardising 0 using 118 and 65) ⇒ P(Z < –1.81 to 1.82) ⇒ **0.03 to 0.04** (AWFW) **AND** **negative usage/volume** is impossible ⇒ A1 **or** ⇒ 0 is (1.81 to 1.82)SDs from mean **AND** **negative usage/volume** is impossible ⇒ A1			
(ii)	Sample (size/number/n) is large **or** 80/sample (size/number/n) is greater than 25/30 so	B1		OE OE; is sufficient/is enough/implies
	can apply/use Central Limit Theorem (**CLT**)	Bdep1	**2**	Dependent on B1
Notes	**1** Even if CLT is stated, then reference to parent population is thus normal ⇒ Bdep0 **2** Value(s) of (population) standard deviation (and mean) is/are known ⇒ B0 Bdep0			
(b)(i)	98% (0.98) ⇒ z = **2.32 to 2.33**	B1		AWFW (2.3263)
	CI for μ is: $118 \pm \begin{pmatrix} 2.05 \text{ to } 2.06 \\ 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{pmatrix} \times \frac{(65 \text{ or } 65.4(\text{AWRT}))}{\sqrt{80 \text{ or } 79}}$	M1		Evaluation of only one CL ⇒ M0 Ignore notation $\sqrt{\frac{65^2 \times 80}{79}} = 65.4101$
	Thus $118 \pm (2.32 \text{ to } 2.33) \times \frac{65}{\sqrt{80}}$	A1		Fully correct expression
	Hence **118 ± 17** **or** **(101, 135)**	Adep1	**4**	CAO/AWRT (16.90574) Dependent on A1 AWRT
Notes	**1** A **correct** answer with no working ⇒ 4 marks **2** **Seen** use of t-value (2.37 to 2.38) ⇒ 0 marks **3** An incorrect expression for CI followed by a numerically correct CI ⇒ 2 solutions ⇒ ((0 or 1) + 4)/2 ⇒ 2 marks			
(ii)	**Clear correct comparison** of **140** with **CI** eg 140 is outside/above CI **or** 140 > UCL	BF1		F on CI providing it does **not** contain 140 Must be an **interval** but quoting values for limits is **not** required
	Disagree with/doubt/reject **claim** **or** μ unlikely to be/is not 140	Bdep1	**2**	OE; dependent on BF1
Notes	**1** Statement must clearly indicate that "140 is outside/above the CI" **or** "140 > UCL" **2** "It/mean/value/OE" is outside/above CI **or** greater than UCL ⇒ BF0 **3** Statements of the form "140 is outside/above 98% of the data/values" ⇒ BF0 **4** Statements such as "**Claim** unlikely/unreasonable/unsupported/incorrect/false/inaccurate/invalid" ⇒ Bdep1 but only if BF1 awarded			
		Total	**10**	