OXFORD
INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL A-LEVEL MATHEMATICS

(9660)

Mark scheme

Statistics Unit 2

Principal Examiners have prepared these mark schemes for specimen papers. These mark schemes have not, therefore, been through the normal process of standardising that would take place for live papers.

Key to mark scheme abbreviations

M	Mark is for method
m	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**	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
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.

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	Answer	Marks	Comments
1(a)	$H_0 : \mu = 35$ $H_1 : \mu \neq 35$ 2 - tail test, 1% sig. level under H_0 , $\overline{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$	B1	
	$\overline{X} \sim N\left(35, \frac{144}{100}\right)$	B1	
	$z = \frac{37.9 - 35}{1.2}$	M1	$z = \frac{37.9 - 35}{\text{their } \sigma/\sqrt{n}}$
	$z = 2.42$	A1ft	On their $\sigma/\sqrt{n}$
	$z_{crit} = \pm 2.5758$	B1	
	do not reject H_0	A1ft	On their z
	Evidence to support the claim that the mean age is 35 years	E1ft	
1(b)	Accept H_0 when H_0 false Accepting the mean to be 35 years when it isn't	B2	Allow B1 if not in context
	Total	**9**	

Q	Answer	Marks	Comments
2(a)	$\mathrm{F}(t) = \int_0^t 5\mathrm{e}^{-5t}\,dt = \left[-\mathrm{e}^{-5t}\right]_0^t$	M1A1	If result quoted without proof award B1 Incorrect notation A0, unless recovery is clear Need not see $t \geq 0$ for A1
	$= 1 - \mathrm{e}^{-5t}$ $\quad t \geq 0$	A1	
	$\mathrm{F}(t) = 0$ otherwise, or $t < 0$	B1	
2(b)	$\mathrm{e}^{-5c} = 0.05 \Rightarrow \mathrm{e}^{5c} = 20$	M1	Accept 0.6 Some attempt to simplify a logarithmic answer is required
	$\Rightarrow c = \frac{1}{5}\ln 20$ $\quad (0.599)$	A1	
	Total	**6**	

Q	Answer	Marks	Comments
3(a)	$\underline{Y \sim N(25.25, 0.35^2)}$ V(mean) = $\frac{\mathbf{0.352}}{\mathbf{10}}$ or **0.0122 to 0.0123** or SD (mean) = $\frac{\mathbf{0.352}}{\sqrt{\mathbf{10}}}$ or **0.11** to **0.111**	B1	**Accept percentage equivalent probabilities** CAO/AWFW (0.01225) CAO/AWFW (0.11068)
	$P(\overline{Y} < 25) = P\left(Z < \frac{25 - 25.25}{0.35/\sqrt{10}}\right)$	M1	Standardising 25 using 25.25 and $0.35/\sqrt{10}$ oe but allow $(25.25 - 25)$ Correct area change
	$= P(Z < -2.25877) = 1 - P(Z < 2.25877)$ $= 1 - (0.98809 \text{ to } 0.98778)$	m1	May be implied by a **correct** answer **or** an answer < 0.5
	= **0.011** to **0.013**	A1	AWFW (0.01195) (0.987 to 0.989) $\Rightarrow$ B1 M1 m0 A0
3(b)	$P(Y > 25) = P\left(Z > \frac{25 - 25.25}{0.35}\right)$	M1	Standardising 25 using 25.25 and 0.35 but allow $(25.25 - 25)$
	$= P(Z > -0.71429) = P(Z < 0.71429)$		
	= **0.761** to **0.764**	A1	AWFW (0.76247) (0.236 to 0.239) $\Rightarrow$ M1 A0 Any p^{10} providing $0 < p < 1$
	P(Y > 25 in each of 10) = $\boldsymbol{p^{10}}$	M1	May be implied by a **correct** answer
	= **0.065** to **0.068**	A1	AWFW (0.06641)
	Total	**8**	

Q	Answer	Marks	Comments
4(a)	$\mu = 128 \div 40 = 3.2$ as required for λ	B1	
	$s^2 = 3.2410\ldots$ (Condone $\sigma^2 = 3.16$)	B1	AWRT 3.24 or 3.16
	Which is close to λ, as required for Poisson	E1	Clearly stated (for either s^2 or σ^2)
4(b)(i)	$1 - P(X \leq 5) = 1 - 0.8946$	M1	For attempt to subtract $P(X \geq 5)$
	$= 0.105(4)$	A1	AWRT
4(b)(ii)	$1 - P(X \leq 7) - P(X \leq 2)$	M1	Attempt to use these two
	$0.9832 - 0.3799$	B1	For either
	$= 0.603(3)$	A1	AWFW 0.603 to 0.604
4(b)(iii)	$1 - P(X \leq 5) = 1 -$ **(b)(i)** or 0.894 to 0.895 P (both) = [1 – **(b)(i)**]^2 or [0.894 to 0.895]^2	M1	
	$= 0.800$	A1	AWFW 0.799 to 0.801
4(c)	Using Po(8.2)	M1	Stated or use in formula or either of figures stated below seen
	$e^{-8.2} \times 8.2^9 \div 9! + e^{-8.2} \times 8.2^{10} \div 10!$	m1	Or Calc $P(\leq 10) - P(\leq 8)$ $= 0.79555 - 0.56465$
	$= 0.231$	A1	AWRT
	Total	**13**	

Q	Answer	Marks	Comments
5	$H_0 : p = 0.50$	B1	
	$H_1 : p > 0.50$	B1	
	$P(X \geq 29 \mid B(50, 0.50) =$	M1	Use of B(50, 0.50); may be implied
	$1 -$ (0.8389 or 0.8987)	M1	AWFW (0.16112)
	$= 0.16$ to 0.165	A1	
	No evidence to support the claim	A1ft	ft on 10% and (p-value $>$ 0.10) Definitive conclusion $\Rightarrow$ A0ft
	Total	**6**	

Q	Answer	Marks	Comments
6(a)(i)	Volume V ~ N (412, 8^2) P($V < 400$) = P$\left(Z < \frac{400 - 412}{8}\right)$	M1	Standardising 400 with 412 and 8
	= P($Z < -1.5$) = 1 – P($Z < 1.5$)	M1	Area change May be implied by correct answer or an answer < 0.5
	= 1 – 0.93319 = 0.066 to 0.067	A1	AWFW (0.06681)
6(a)(ii)	P($V > 420$) = P($Z > 1$)	B1	CAO but ignore inequality and sign May be implied by a correct answer
	= 1 – P($Z < 1$) = 1 – 0.84134 = 0.158 to 0.159	B1	AWFW (0.15866)
6(a)(iii)	P($V = 410$) = 0 or zero	B1	Ignore any working B0 for 'impossible to calculate' or 'no answer'
6(b)(i)	A statement/indication that (–) 1.6449 and/or 2.3263 are z-values Do **not allow** ϕ (0.99) = 2.3263, etc but **allow** ϕ^{-1} (0.99) = 2.3263 Do not award for z-value(s) simply embedded in standardisation statement(s)	B1	Simple statement that $z = \pm 1.6449$ and/or $z = \pm 2.3263$ **or** sketch of normal curve with at least one z-value marked
	A clear use of $z = \frac{v - \mu}{\sigma}$ or $v = \mu + z\sigma$ with 400 and/or 420 (condone sign errors)	M1	SC immediate algebraic use of $v - \mu = z\sigma \Rightarrow$ B1 M1 A0
	The two given equations correctly derived	A1	AG; watch for sign inconsistencies
6(b)(ii)	Thus $20 = (2.3262 + 1.6449)\sigma$	M1	A sensible (one that would lead to values required if completed correctly) attempt at solving the two given equations by eliminating μ or σ Do **not allow** MC or MR
	$\sigma = 5.04$	A1	AWRT (5.03626)
	$\mu = 408$	A1	AWRT (408.284)
	Total	**12**	

Q	Answer	Marks	Comments
7(a)	Putting $\frac{t^3}{216} = 0.9$	M1	
	$t = 5.793$	A1	5.79 to 5.80
	41 days	A1	Accept 40 days in this context
7(b)	Attempt to differentiate $\mathrm{F}(t)$	M1	ct^2 seen
	$\mathrm{f}(t) = \frac{1}{72}t^2$, $0 \le t \le 6$	A1	Condone domain missing here
	$= 0$ otherwise	A1	For complete function
7(c)	Attempt to integrate $t\mathrm{f}(t)$ from 0 to 6	M1	Using their $\mathrm{f}(t)$ from **(b)** ct^4 seen
	$E(T) = 4.5$	A1	
	Attempt to integrate $t^2\mathrm{f}(t)$ from 0 to 6	M1	Using their $\mathrm{f}(t)$ from **(b)** ct^5 seen
	$E(T^2) = 21.6$	A1	
	$\mathrm{Var}(T) = E(T^2) - (E(T))^2$	m1	Applied in this case Dependent on both M1
	$= 21.6 - 4.5^2 = 1.35$	A1	
7(d)	s.d. $= \sqrt{1.35} = 1.162$	M1	For $\sqrt{}$(their Var) $0 < \mathrm{Var}(T) < 9$
	Use of F(5.662)	m1	For F(their s.d. + their E(T)) provided $0 <$ Total < 6
	$1 - \frac{5.662^3}{216}$	m1	
	$= 0.160$	A1	AWFW 0.159 to 0.161
	Total	**16**	

Q	Answer	Marks	Comments
8	$H_0 : \mu = 568$ $H_1 : \mu < 568$ 1% one-tailed test	B1	X ~ contents of cartons of milk $X \sim N(568, \sigma^2)$ Under H_0 : $\overline{X} \sim N\left(568, \frac{\sigma^2}{n}\right)$
	$v = 7$	B1	
	$\bar{x} = \frac{4510}{8} = 563.75$	B1	
	$\Rightarrow s^2 = \frac{254256.8}{7} - \frac{8}{7}(563.75)^2$ $s^2 = 7.929$	B2	($s = 2.816$)
	$t = \frac{563.75 - 568}{2.816/\sqrt{8}}$	M1	
	$t = -4.27$	A1ft	
	$t_{crit} = -2.998$	B1ft	
	reject H_0	A1ft	On their t
	Evidence at the 1% level of significance to suggest that the average contents of the cartons has been reduced	E1ft	
	Total	**10**	

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