

MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers

9709 MATHEMATICS

9709/71

Paper 7, maximum raw mark 50

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1	$z = 2.326$ $494 \pm z \times \frac{23}{\sqrt{150}}$ $= 490 \text{ to } 498 \text{ (3 sfs)}$	B1 M1 A1 [3]	seen Any z
2	$(0.75 \times 54.8 + 0.25 \times 82.4 =) 61.7$ $0.75^2 \times 16.0^2 + 0.25^2 \times 4.8^2$ $(= 145.44)$ $\text{sd} = 12.1 \text{ (3 sfs)}$	B1 M1 A1 [3]	No need for $\sqrt{\quad}$ for M1
3	$H_0: p = 0.15$ $H_1: p > 0.15$ $(N(300 \times 0.15, 300 \times 0.15 \times 0.85))$ $= N(45, 38.25)$ $\frac{59.5 - 45}{\sqrt{38.25}} (= 2.345)$ Allow wrong or no cc $z = 1.96 \quad 2.345 > 1.96$ Evidence prop is higher for new plan	B1 B1 M1 M1 A1 [5]	or H_0 : Approval rate same for new as for old H_1 : Approval rate for new $>$ for old $(N(0.15, \frac{0.15 \times 0.85}{300}))$ $= N(0.15, 0.000425)$ or $\frac{\frac{59}{300} + \frac{0.5}{300} - 0.15}{\sqrt{0.000425}} (= 2.345)$ Allow wrong or no cc comparison (or area comparison) cwo
4 (i)	$\int_0^1 \frac{k}{(x+1)^2} dx = 1$ $-\left[\frac{k}{x+1}\right]_0^1 = 1$ $-k\left(\frac{1}{2} - 1\right) = 1$ $(k = 2 \text{ AG})$	M1 A1 [2]	Any attempt integ $f(x)$ & $= 1$. Ignore limits oe, with limits inserted correctly
(ii)	$\int_0^a \frac{2}{(x+1)^2} dx = \frac{1}{5}$ $-\left[\frac{2}{x+1}\right]_0^a = \frac{1}{5}$ $-\left(\frac{2}{a+1} - 2\right) = \frac{1}{5}$ $a = \frac{1}{9}$	M1 A1 A1 [3]	Attempt integ $f(x)$ & $= \frac{1}{5}$ (oe), ignore limits oe, with correct limits inserted correctly
(iii)	Area below $x = 0.5$ is greater than 0.5 $m < 0.5$	B1 B1dep [2]	oe, eg More area at left hand end

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5 (i) (a)	$P(X \geq 3) = 1 - e^{-3.2} \left(1 + 3.2 + \frac{3.2^2}{2!} \right)$ $= 0.62(0) \text{ (3 sf)}$	M1 A1 [2]	Allow one end error
(b)	$P(X = 3) = e^{-3.2} \left(\frac{3.2^3}{3!} \right) \quad (= 0.22262)$ $\left(\frac{P(X=3 \cap X \geq 3)}{P(X \geq 3)} = \frac{P(X=3)}{P(X \geq 3)} \right)$ $= \frac{0.22262}{0.62010}$ $= 0.359 \text{ (3 sf)}$	M1 M1 A1 [3]	May be implied Their $P(X=3)$ Their $P(X \geq 3)$
(ii) (a)	(Approx) normal with mean 3.2 variance = $\frac{3.2}{120}$ or $\frac{2}{75}$ or 0.0267 (3 sfs) oe	B1 B1 [2]	or sd = $\sqrt{\frac{3.2}{120}}$ or 0.163 (3 sfs) oe
(b)	$\frac{3.3-3.2}{\sqrt{\frac{3.2}{120}}} \quad (= 0.612)$ $\Phi(0.612)$ $= 0.730 \text{ (3 sfs)}$	M1 M1 A1 [3]	Allow with cc attempted Accept 0.73
6 (i)	$\bar{x} = 1.96$ $(\Sigma x^2 f = 254)$ $S^2 = \frac{50}{49} x \left(\frac{254}{50} - 1.96^2 \right)$ $= \frac{1548}{1225} \text{ or } 1.2637$	B1 M1 A1 [3]	Correct sub in S^2 formula
(ii)	$H_0: \text{Pop mean} = 1.66$ $H_1: \text{Pop mean} \neq 1.66$ $\frac{1.96-1.66}{\sqrt{\frac{1.2637}{50}}}$ $= 1.887$ $z = 1.96 \quad 1.887 < 1.96$ No evidence that mean has changed	B1 M1 A1 M1 A1 _{ft} [5]	$H_0: \text{Pop mean} = 1.66$ $H_1: \text{Pop mean} > 1.66$ $\frac{1.96-1.66}{\sqrt{\frac{1.2637}{50}}}$ $= 1.887$ $z = 1.645$ Evidence mean has changed B0 M1 A1 M1 A1_{ft} In context
(iii)	No because H_0 not rejected	B1f [1]	If H_0 rejected in (ii): Yes because H_0 rejected
(iv)	State mean not changed when it has $-1.96 < \text{test stat} < 1.96$	B1 B1 [2]	In context State mean not increased when it has test stat < 1.645

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7 (i)	$\lambda = 5$ $1 - e^{-5} \left(1 + 5 + \frac{5^2}{2!} \right)$ $= 0.875$	B1 M1 A1 [3]	Any λ . Allow one end error
(ii)	$X \sim N(120, 120)$ $\frac{109.5-120}{\sqrt{120}} (= -0.9585)$ $1 - \Phi("0.9585")$ $(= 1 - 0.8312)$ $"0.1688"^{*2}$ $= 0.0285 \text{ to } 0.0286$	B1 M1 M1 A1 [4]	May be implied Allow with wrong or no cc or no $\sqrt{}$
(iii)	$\lambda = 15 \times \frac{5}{60} + 0.5$ $= 1.75$ $e^{-1.75} \left(\frac{1.75^3}{3!} + \frac{1.75^4}{4!} + \frac{1.75^5}{5!} \right)$ $= 0.247 \text{ (3 sfs)}$	M1 A1 M1 A1 [4]	Any λ . Allow one end error

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1 (i)	H_0 : Pop mean = 3 H_1 : Pop mean > 3	B1 [1]	Allow μ or λ , but not just ‘mean’
(ii)	$0.0683 > 0.05$ No evidence that pop mean increased	M1 A1ft [2]	For inequality stated or clearly shown on dig. Allow ‘No increase in mean’
[Total: 3]			
2 (i)	$7, \sqrt[3]{n}$	B1, B1 [2]	oe
(ii) (a)	Pop is normal	B1 [1]	Allow X is normal
(b)	Large sample	B1 [1]	or large n (can be implied by $n \geq 30$)
[Total: 4]			
3 (i)	$p = \frac{18}{50}$ or 0.36 oe $z = 2.326$ $0.36 \pm z \sqrt{\frac{0.36 \times (1-0.36)}{50}}$ $= 0.202$ to 0.518 (3 sfs)	B1 B1 M1 A1 [4]	Allow any z ($\neq 0$ or 1) Allow any brackets or none
(ii)	Sample random	B1 [1]	oe
[Total: 5]			
4 (i)	$\lambda = 8 \times 0.32 + 12 \times 0.45$ (= 7.96) $1 - e^{-7.96}(1 + 7.96 + \frac{7.96^2}{2})$ $= 0.986$ (3 sfs)	M1 M1 A1 [3]	$1 - P(X \leq 2)$, any λ allow one end error
(ii)	$\lambda = 155 \times 0.32 = 49.6$ $N(‘49.6’, ‘49.6’)$ $\frac{34.5 - ‘49.6’}{\sqrt{‘49.6’}}$ (= -2.144) $\Phi(‘-2.144’) = 1 - \Phi(‘2.144’)$ $= 0.016(0)$	B1 M1 M1 M1 A1 [5]	$N(\lambda, \lambda)$ any λ . May be implied Allow no or wrong cc & no $\sqrt{}$ Correct area consistent with their working
[Total: 8]			
5 (i)	$F + J \sim N(24, 2.8^2 + 2.6^2)$ $\frac{30-24}{\sqrt{14.6}}$ (= 1.570) $P(F + J < 30) = \Phi(‘1.570’)$ 0.942 (3 sfs)	B1 M1 M1 A1 [4]	or $N(24, 14.6)$ for correct mean and variance Allow without $\sqrt{}$ (ignore false cc) Correct area consistent with their working

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(ii)	$F - 2J \sim N(-11.4, 2.8^2 + 4 \times 2.6^2)$ $\frac{0 - (-11.4)}{\sqrt{34.88}} (= 1.930)$ $P(F - 2J) > 0$ $= 1 - \Phi(1.930)$ $= 0.0268$ (3 sfs)	B1 M1 M1 A1 [4]	or $N(-11.4, 34.88)$ for correct mean and variance Allow without $\sqrt{\quad}$ (ignore false cc) Correct area consistent with their working or similar scheme using $2J - F$
[Total: 8]			
6 (i)	$\int_4^{25} kx^{-\frac{1}{2}} dx = 1$ $\left[\frac{kx^{\frac{1}{2}}}{\frac{1}{2}} \right]_4^{25} = 1$ $2k(5 - 2) = 1$ $(k = \frac{1}{6} \text{ AG})$	M1 A1 [2]	Attempt integrate & = 1. Ignore limits or equiv correct subst of correct limits
(ii)	$\frac{1}{6} \int_4^{25} x^{\frac{1}{2}} dx$ $= \frac{1}{6} \left[\frac{x^{\frac{3}{2}}}{\frac{3}{2}} \right]_4^{25} (= \frac{1}{9} (125 - 8))$ $= 13$	M1 A1 A1 [3]	Attempt integ $xf(x)$. Ignore limits Correct integrand and limits Or 117/9
(iii)	$\frac{1}{6} \int_{20}^{25} x^{-\frac{1}{2}} dx$ $(= \frac{1}{6} \left[\frac{x^{\frac{1}{2}}}{\frac{1}{2}} \right]_{20}^{25} = \frac{1}{3} (5 - \sqrt{20}))$ $= 0.176$ (3 sfs)	M1 A1 [2]	Attempt integ $f(x)$ from 20 to 25 Or $1 - \int_4^{20} \frac{1}{\sqrt{x}}$ Accept surd form
(iv)	Wkly demand may be > 25 (or < 4)	B1 [1]	or other sensible
[Total: 8]			
7 (i)	$H_0: \mu = 2.0 \quad H_1: \mu \neq 2.0$ $\bar{x} = \frac{430}{200} = 2.15$ $s^2 = \frac{200}{199} \left(\frac{1290}{200} - \left(\frac{430}{200} \right)^2 \right)$ $= 1.8366834$ $\frac{2.15 - 2.0}{\sqrt{\frac{1.8366834}{200}}} (= 1.565)$ $z = 1.645$ No evidence that $\mu \neq 2.0$	B1 B1 B1 M1 M1 A1 [6]	For $\bar{x}$ Correct subst in s^2 formula For s^2 correct (or $s = 1.35524$) For standardising (need 200) accept sd/var mixes For correct comparison of z values or areas Cwo (condone biased variance for last 3 marks)

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	(ii)	0.005 or 0.5%	B1 1	Not just 0.5
[Total 4]				
2	(i)	$E(3X - Y) = 12.1$ $\text{Var}(3X - Y) = 9 \times 14 + 15 = (141)$ $\frac{20-12.1}{\sqrt{141}}$ $\Phi(0.665)$ $= 0.747 \text{ (3 sfs)}$	B1 B1 M1 M1 A1 5	Allow without $\sqrt{}$ (No Continuity Correction) Correct area consistent with their working
[Total 5]				
3	(i)	$\bar{x} = \frac{7520}{150} = (50.1) \text{ (3 sfs)}$ $s^2 = \frac{150}{149} \left(\frac{413540}{150} - \left(\frac{7520}{150} \right)^2 \right)$ $= 245 \text{ or } 246 \text{ (3 sfs)}$	B1 M1 A1 3	Attempt at unbiased variance (either formula) Allow $s^2 = 15.7^2 \text{ (3 sfs)}$
	(ii)	$\frac{53 - \frac{7520}{150}}{\sqrt{\frac{245.217}{80}}} \quad (= 1.637 \text{ to } 1.638)$ $1 - \Phi(1.637)$ $= 0.0488 \text{ to } 0.0509$	M1 M1 A1 3	For Standardising ($\pm$) with their mean and their variance must have $\sqrt{80}$ (ignore cc) Correct area consistent with their working Correct working only
[Total 6]				
4	(i)	$1 - e^{-0.8}(1 + 0.8)$ $= 0.191 \text{ (3 sfs)}$	M1 A1 2	Allow one end error
	(ii)	$\lambda = 3 \times 0.8 + 2 \times 2.7 \quad (= 7.8)$ $e^{-7.8} \left(1 + 7.8 + \frac{7.8^2}{2} + \frac{7.8^3}{3!} + \frac{7.8^4}{4!} \right)$ $= 0.112 \text{ (3 sfs)}$	M1 M1 A1 3	Attempt find λ P(0, 1, 2, 3, 4) Using their λ . Allow one end error
	(iii)	$e^{-0.8n} < 0.1$ Allow '=' $-0.8n < \ln 0.1$ Allow '=' $\min n = 3$	M1* M1* dep A1 3	or $e^{-x} < 0.1$ $-x < \ln 0.1$ Correctly obtained
[Total 8]				$e^{-1.6} = 0.20$ } M1 for trial and improvement to find P(0) try $n = 2$ $e^{-2.4} = 0.09$ } M1*dep try $n = 3$ both correct $n = 3$ A1

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5	(i)	$P(> 9 \text{ Heads} \mid \text{unbiased}) = {}^{12}C_{10} \times 0.5^{10} \times 0.5^2 + 12 \times 0.5^{11} \times 0.5 + 0.5^{12}$ $= 0.0193$ Level is 1.93% or 1.9%	M1 M1 A1 3	Allow Bin $P(X = 9, 10, 11, 12)$ correct or $1 - P(X = (9), 10, 11, 12)$ any p/q Allow Bin $P(X = 9, 10, 11, 12)$ correct p/q Allow 2% if correct working seen
	(ii)	$B(100, 0.5) \approx N(50, 25)$ $\frac{x - 0.5 - '50'}{\sqrt{25}} = z$ $z = 1.645$ $x = 58.7$ Rejection region is > 59	B1 M1 B1 A1 A1ft 5	Or proportion method $N(0.5, 0.0025)$ Allow with wrong or no cc or no $\sqrt{\quad}$ (cc for proportion method $0.5/100$) + only (consistent with their standardisation) or > 58 (region and integer required)
[Total 8]				
6	(i)	Test is for bias in one direction One-tail	B1 B1 2	'Increased' rather than 'changed' or statement that $\mu > 45.7$ dep 1st B1
	(ii)	H_0: pop mean = 45.7 H_1: pop mean > 45.7 $\bar{x} = 47.375$ or 47.4 or 379/8 $\frac{'47.375' - 45.7}{\frac{3.2}{\sqrt{8}}}$ (= 1.481 to 1.503)) $z = 1.645$ '1.481' < 1.645 hence no evidence mean time increased (AG)	B1 B1 M1 M1 A1 5	Allow μ, but not 'mean' (follow through their (i)) Allow without $\sqrt{\quad}$ Explicit comparison with their z from table Comparison with 1.645 or probability (0.0664 to 0.0693) with 0.05 Correct conclusion – accept H_0 No errors seen
		Not rejected H_0 Type II possible	B1 B1 2	dep 1st B1 No contradictions for either mark
[Total 9]				

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7 (i)	$k \int_0^{\frac{2\pi}{3}} \sin x dx = 1$ $k[-\cos x]_0^{\frac{2\pi}{3}}$ $k[-\cos \frac{2\pi}{3} + \cos 0] = 1$ $k[0.5 + 1] = 1$ $(k = \frac{2}{3} \text{ AG})$	M1 A1 2	Integ & = 1. Ignore limits Must see this line or next
(ii)	$\frac{2}{3} \int_0^m \sin x dx = 0.5$ $\frac{2}{3}[-\cos x]_0^m = 0.5$ $\frac{2}{3}(-\cos m + 1) = 0.5$ $\cos m = 0.25$ $m = 1.32 \text{ (3 sfs) AG}$	M1* M1* dep A1 A1 4	Integ & = 0.5. Ignore limits Correct integrand & limits 0 to unknown & = 0.5 But allow a cos m = b where b/a = 0.25 dep cos m = 0.25 seen NB accept full verification
(iii)	$\frac{2}{3} \int_0^{\frac{2\pi}{3}} x \sin x dx$ $= \frac{2}{3} \left\{ [x(-\cos x)]_0^{\frac{2\pi}{3}} - \int_0^{\frac{2\pi}{3}} (-\cos x) dx \right\}$ $= \frac{2}{3} \left\{ \frac{\pi}{3} - 0 - [-\sin x]_0^{\frac{2\pi}{3}} \right\}$ $= \frac{2}{3} \left(\frac{\pi}{3} + \sin \frac{2\pi}{3} \right)$ $= \frac{2\pi + 3\sqrt{3}}{9} \text{ or } 1.28 \text{ (3 sf)}$	M1 M1* dep M1* dep A1 4	Integ $xf(x)$. Ignore limits 1st step attempted ie $x(-\cos x)$ oe. Ignore limits 2nd step attempted including correct limits applied oe
[Total 10]			