

121/2 MATHEMATICS ALT. A

SECTION I

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No.	Marking scheme	Marks	Comments
1.	<p>Let the ratio of maize to millet = $x : y$</p> $\frac{60x + 90y}{x + y} = 85 \checkmark$ $60x + 90y = 85x + 85y$ $25x = 5y \quad 60x + 90(1-x) = 85$ $\frac{x}{y} = \frac{1}{5}$ $x : y = 1 : 5$ <p>% of maize flour = $\frac{1}{6} \times 100\% \checkmark$</p> $= 16\frac{2}{3}\% \checkmark$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>3</p>	<p>Or equivalent $\begin{matrix} 60 & 90 \\ & \swarrow \searrow \\ & 85 \end{matrix}$</p> <p>or equivalent $\begin{matrix} 5 & 25 \end{matrix}$</p> <p>$\frac{5}{30} \times 100$</p> <p>accept 16.67</p>
2.	<p>Let the first term be a and the common difference r</p> $a + ar = 20 \dots \dots (i)$ $ar + ar^2 = 30 \dots \dots (ii)$ <p>from (i), $a = \frac{20}{1+r}$</p> <p>from (ii) $a = \frac{30}{r+r^2}$</p> $\frac{20}{1+r} = \frac{30}{r+r^2}$ $2r^2 + 2r = 3 + 3r$ $2r^2 - r - 3 = 0$ $(r+1)(2r-3) = 0$ $r = \frac{3}{2} = 1.5 = 1\frac{1}{2}$	<p>M1</p> <p>m1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>4</p>	<p>For both equalities correctly formed</p> <p>Equation in one variable</p> <p>Correct attempt to solve.</p> <p>Accept $1\frac{1}{2}$ or 1.5</p>

$ar + ar^2 = 20r$
 $ar + ar^2 = 30$
 $20r - 30 = 0$

No.	Marking scheme	Marks	Comments
3.	$\frac{1}{\sin 75^\circ} = \frac{4}{\sqrt{6} + \sqrt{2}}$ $= \frac{4(\sqrt{6} - \sqrt{2})}{(\sqrt{6} + \sqrt{2})(\sqrt{6} - \sqrt{2})}$ $= \frac{4(\sqrt{6} - \sqrt{2})}{6 - 2}$ $= \sqrt{6} - \sqrt{2}$	M1 A1 2	Denominator rationalized
4.	<p>(a) $(1 - \frac{3}{10}x)^5 = 1 + 5 \times 1 \times (\frac{-3x}{10}) + 10 \times 1 \times (\frac{-3x}{10})^2$ $+ 10 \times 1 \times (\frac{-3x}{10})^3 + 5 \times 1 \times (\frac{-3x}{10})^4 + (\frac{-3x}{10})^5$ ✓</p> $= 1 - \frac{3}{2}x + \frac{9}{10}x^2 - \frac{27x^3}{100} + \frac{81x^4}{2000} - \frac{243x^5}{100000}$ <p>(b) When $x = 0.1$,</p> $\left(1 - \frac{3}{10} \times \frac{1}{10}\right)^5 = 1 - \frac{3}{2} \times \frac{1}{10} + \frac{9}{10} \times \left(\frac{1}{10}\right)^2$ $(0.97)^5 = 1 - 0.15 + 0.009$ $= 0.859$	M1 A1 M1 A1 4	Initial expansion correct. Coefficients must be fraction. ✓ substitution in the 1st three terms. Accept $\frac{859}{1000}$.
5.	$AC = \sqrt{(15^2 + 8^2)} = \sqrt{289} = 17$ $OC = 8.5$ $OF = \sqrt{5^2 + 8.5^2} = \sqrt{97.25}$ $= 9.862$ $\sin \frac{1}{2}\theta = \frac{7.5}{9.862}$ $\frac{1}{2}\theta = \sin^{-1} 0.7605$ $2\theta = 2 \sin^{-1} 0.7605$ $\theta = 2 \times 49.51$ $= 99.02^\circ$	M1 A1 3	Using cosine rule Cos $\theta = \frac{2 \times 9.862^2 - 15^2}{2 \times 9.862^2}$ ^{2nd m1} $= -0.1567$ $\theta = 99.01$ A1 $\theta = \frac{2 \times 9.862^2 - 15^2}{2 \times 9.862^2}$ last method when all other method exhausted

$$\tan \alpha = \frac{7.5}{6.403} = 1.171$$

$$\alpha = \tan^{-1} 1.171$$

$$\alpha = 49.5 \times 2 = 99$$

No.	Marking scheme	Marks	Comments
9.		<p>B1 --- Line 3.5cm from AB and parallel to AB</p> <p>B1 --- Semi circle, centre M, radius AM and broken arc. <i>if continuous arc has to be drawn</i></p> <p>B1 ✓ Shaded area</p>	<p>B1</p> <p>B0</p> <p>B1 ✓</p>
10.	<p>NM = Single matrix that would map P onto P'</p> $= \begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix} \begin{pmatrix} 1 & -1 \\ 2 & 3 \end{pmatrix}$ $= \begin{pmatrix} 3 & 2 \\ 3 & 7 \end{pmatrix}$ <p>$(NM)^{-1}$ = Single matrix that would map P' onto P'</p> <p>det = 21 - 6 = 15</p> $(NM)^{-1} = \frac{1}{15} \begin{pmatrix} 7 & -2 \\ -3 & 3 \end{pmatrix}$ $\begin{pmatrix} \frac{7}{15} & -\frac{2}{15} \\ -\frac{1}{5} & \frac{1}{5} \end{pmatrix}$	<p>M1</p> <p>A1</p> <p>B1</p>	<p><i>double tick if 2nd B is lost due to continuous c'</i></p> $\begin{pmatrix} \frac{3}{5} & \frac{1}{5} \\ -\frac{2}{5} & \frac{1}{5} \end{pmatrix} \begin{pmatrix} \frac{2}{3} & -\frac{1}{3} \\ \frac{1}{3} & \frac{1}{3} \end{pmatrix} m_1$ $\begin{pmatrix} \frac{7}{15} & -\frac{2}{15} \\ -\frac{1}{5} & \frac{1}{5} \end{pmatrix} A_1 B_1$ <p>Allow</p> $\begin{pmatrix} \frac{7}{15} & -\frac{2}{15} \\ -\frac{3}{15} & \frac{3}{15} \end{pmatrix}$
		3	

$$\frac{1}{3} \begin{pmatrix} 2 & -1 \\ 1 & 1 \end{pmatrix} \frac{1}{5} \begin{pmatrix} 3 & 1 \\ -2 & 1 \end{pmatrix}$$

$$\frac{1}{15} \begin{pmatrix} 3 & 1 \\ -2 & 1 \end{pmatrix} \begin{pmatrix} 2 & -1 \\ 1 & 1 \end{pmatrix} m_1$$

$$= \frac{1}{15} \begin{pmatrix} 7 & -2 \\ -3 & 3 \end{pmatrix}$$

$$\begin{pmatrix} \frac{7}{15} & -\frac{2}{15} \\ -\frac{3}{15} & \frac{3}{15} \end{pmatrix} A_1 B_1$$

No.	Marking scheme	Marks	Comments
11.	<p>(a)</p> <p>(b)</p> <p>Rate of change of h with $t = \frac{100 - 50}{0 - 2}$ $= -25 \text{ cm/hr}$</p>	<p>BT P₁</p> <p>BT L₁</p> <p>B1 3</p>	<p>At 1.5, $h = 64$.</p> <p>and at 2.1, $h = 46$.</p> <p>(3.9 & 4)</p> <p>✓ plotting of all 7 points coordinates</p> <p>✓ line of best fit</p> <p>✓ gradient</p>
12.	<p>$\Sigma d = 0$</p> <p>$-4 + 5 + -3 + -2 + d + 1 = 0$</p> <p>$d - 3 = 0$</p> <p>$d = 3$</p> <p>Variance = $\frac{(-4)^2 + 5^2 + (-3)^2 + (-2)^2 + 3^2 + 1^2}{6}$</p> <p>$= \frac{64}{6}$</p> <p>$= 10\frac{2}{3}$</p>	<p>B1</p> <p>M1</p> <p>A1 3</p>	<p>C.A.O</p>

No.	Marking scheme	Marks	Comments
13.	<p>Amount borrowed = $27\,500 - 17\,250 = 10\,250$</p> <p>Amount paid back = $6 \times 2100 = 12\,600$</p> <p>$10250 \left(1 + \frac{r}{100}\right)^6 = 12600$ →</p> <p>$1 + \frac{r}{100} = \sqrt[6]{1.229}$</p> <p>$= 1.035$ →</p> <p>$r = 3.5\% \text{ p.m}$ →</p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>3</p>	<p>for the 6th root.</p>
14.	<p>$\sin^2 \theta - \cos^2 \theta = -\frac{1}{2}$</p> <p>$\sin^2 \theta - (1 - \sin^2 \theta) = -\frac{1}{2}$</p> <p>$2\sin^2 \theta = \frac{1}{2}$</p> <p>$\sin^2 \theta = \frac{1}{4}$</p> <p>$\sin \theta = \pm \frac{1}{2}$</p> <p>$\theta = 30^\circ, 150^\circ, 210^\circ, 330^\circ$</p>	<p>M1</p> <p>A1</p> <p>B2</p> <p>4</p>	<p>for substitution of $\cos^2 \theta$ or equivalent</p> <p>Allow A1 for $\sin \theta = \frac{1}{2}$</p> <p>Allow B1 for 2 or 3 ✓ for 2 angles</p>
15.	<p>$PQ = \begin{pmatrix} 3 \\ 3 \\ 1 \end{pmatrix} - \begin{pmatrix} 1 \\ -1 \\ 3 \end{pmatrix} = \begin{pmatrix} 2 \\ 4 \\ -2 \end{pmatrix}$</p> <p>$PR = \begin{pmatrix} 6 \\ 9 \\ -2 \end{pmatrix} - \begin{pmatrix} 1 \\ -1 \\ 3 \end{pmatrix} = \begin{pmatrix} 5 \\ 10 \\ -5 \end{pmatrix}$</p> <p>$k \begin{pmatrix} 5 \\ 10 \\ -5 \end{pmatrix} = k \begin{pmatrix} 2 \\ 4 \\ -2 \end{pmatrix}$ →</p> <p>$k = \frac{2}{5}$ →</p> <p>$PQ = \frac{2}{5} PR$. Thus $PQ \parallel PR$</p> <p>P is a common point</p> <p>P, Q and R are collinear.</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>3</p>	<p>or equivalent</p> <p>for conclusion</p>

No.	Marking scheme	Marks	Comments
16.	$S = \int_0^4 (t^2 - 4t + 6) dt$ $= \left[\frac{t^3}{3} - 2t^2 + 6t \right]_0^4$ $= \left(\frac{64}{3} - 2 \times 16 + 6 \times 4 \right) - 0$ $= 13\frac{1}{3} M$	<p>M1</p> <p>M1</p> <p>A1</p> <p>3</p>	<p>✓ integral with limits</p> <p>per substitution</p>

Integrated no limits M1
M1
A1

SECTION II (50 MARKS)

No.	Marking scheme	Marks	Comments
17.	<p>(a) Tractor P alone takes $(5 - 1\frac{2}{3}) = 3\frac{1}{3}$ h ✓</p> <p>Fraction of work done by tractor P and Q in 1 hour</p> $= \frac{1}{5} + \frac{1}{3\frac{1}{3}} = \frac{1}{5} + \frac{3}{10} \checkmark$ $= \frac{1}{2}$ <p>Together P and Q take 2 hours</p>	B1 M1 A1	for $3\frac{1}{3}$ hrs
	<p>(b) Fraction of work done by P and Q in 40 minutes</p> $= \frac{2}{3} \times \frac{1}{2}$ $= \frac{1}{3}$ <p>Balance = $1 - \frac{1}{3} = \frac{2}{3}$</p> <p>Tractor Q alone to do $\frac{2}{3}$ of work</p> $= \frac{2}{3} \div \frac{3}{10} = \frac{2}{3} \times \frac{10}{3}$ $= \frac{20}{9} = 2\frac{2}{9} \text{ hours}$ <p>Total time = $2\frac{2}{9} + \frac{2}{3}$</p> $= 2\frac{8}{9} \text{ hours}$	B1 M1 M1 A1	Allow 2 hr 53
	<p>2 hrs 53 min 20 sec</p> <p>(c) In 1 h both P and Q do $\frac{1}{2}$ of the work</p> <p>Fraction of work done by P and Q in 1h 12 min</p> $= \frac{6}{5} \times \frac{1}{2} = \frac{3}{5}$ <p>Balance = $1 - \frac{3}{5} = \frac{2}{5}$</p> <p>Payment for tractor R</p> $= \frac{2}{5} \times 20\,000$ $= \text{Ksh } 8\,000$	B1 M1 A1	for $\frac{2}{5}$
		10	

No.	Marking scheme	Marks	Comments
18.	<p>(a)(i) Moraa's monthly taxable income</p> $= 40\,000 + 11\,090 + 7\,000$ $= \text{ksh } 58\,090$	<p>B1 B1</p>	
	<p>(ii)</p> <p>Tax in 1st slab = $\frac{10}{100} \times 11\,180 = 1118$</p> <p>Tax in 2nd slab = $\frac{15}{100} \times 10\,534 = 1580.1$</p>	M1	
	<p>Tax in 3rd slab = $\frac{20}{100} \times 10\,534 = 2106.8$</p> <p>Tax in 4th slab = $\frac{25}{100} \times 10\,534 = 2633.5$</p>	M1	
	<p>Tax in 5th slab = $\frac{30}{100} \times 15\,308 = 4592.4$</p>	M1	
	<p>Total income tax</p> $= 1118 + 1580.1 + 2106.8 + 2633.5 + 4592.4$ $= 12\,030.8$	A1	
	<p>(b) Relief = $12\,030.80 - 10\,750.8$</p> $= \text{Ksh } 1\,280$	B1	
	<p>(c)(i) Tax in proposed 1st band</p> $= 11180 \times 1.5 \times \frac{10}{100}$ <p style="margin-left: 40px;"><i>1118 x 150 / 100</i></p> $= \text{ksh } 1677$	B1	
	<p>(ii) Amount in last band</p> $= 58090 - (16770 + 10534 \times 3)$ $= 9718$	M1	$\frac{150}{100} \times 11180 = 16770$
	<p>Tax = $\frac{30}{100} \times 9718$</p> $= 2915.40$	M1	$16770 - 11180 = 5590$
		A1	$15308 - 5590 = 9718$
		10	

No.	Marking scheme	Marks	Comments
19.	(a)(i) Price of a pen = $\frac{180}{2x-1}$	B1	
	(ii) Price of a pencil = $\frac{200}{3x+1}$	B1	
	(b) $\frac{180}{2x-1} - \frac{200}{3x+1} = 4$	M1	or equal
	$180(3x+1) - 200(2x-1)(3x+1)$ $180(3x+1) - 200(2x-1) = 4(3x+1)(2x-1)$		
	$(2x-1)(3x+1) = 45(3x+1) - 50(2x-1)$		
	$24x^2 - 140$ $6x^2 - x - 1 = 35x + 95$	M1	formation of quadratic eqn
	$24x^2 - 140x - 384 = 0$ $6x^2 - 36x - 96 = 0$	M1	
	$x^2 - 6x - 16 = 0$		
	$(x+2)(x-8) = 0$	M1	complete factor N attempt to solve
	$x = -2$ or $x = 8$		
	$x = 8$	A1	
	(c) New price of a pen = $\frac{125}{100} \times \left(\frac{180}{16-1}\right)$		
	= Ksh 15	B1	$15m - 8n = 0$ $m + n = 46$
	Price of pencil = $\frac{200}{25} =$ Ksh 8	B1	
	Let number of pens be p		
$\therefore 15p = 8(46 - p)$	M1		
$15p + 8p = 8 \times 46$			
$23p = 8 \times 46$			
$p = \frac{8 \times 46}{23} = 16$	A1		
	10		

No.	Marking scheme	Marks	Comments
20.	(a)(i) Longitude difference between A and B		
	$= 15^\circ + 75^\circ = 90^\circ$	B1	<i>Longitude diff</i>
	$\frac{90}{360} \times 2 \times \frac{22}{7} \times 6370 \cos x = 5005$	M1	
	$\cos x = \frac{5005 \times 7 \times 360}{90 \times 2 \times 22 \times 6370} = 0.5000$		
	$x = 60^\circ$		
	B(60°N, 75°W)	A1	
	(ii) Distance between B and C = $910 \times 3\frac{2}{3} = 3336\frac{2}{3}$	M1	
	$\frac{\theta}{360} \times 2 \times \frac{22}{7} \times 6370 = 3336\frac{2}{3}$	M1	
	$\theta = \frac{3336\frac{2}{3} \times 360 \times 7}{2 \times 22 \times 6370} = 30^\circ$		
	C(30°N, 75°W)	A1	<i>60° - 30°</i>
	(b) Time for entire journey + stop over		
	$= \frac{5005}{910} + 1\text{h } 30\text{ min} + 3\text{h } 40\text{ min}$	M1	<i>- Total time take</i>
	$= 10\text{ h } 40\text{ min}$		
	Time difference due to longitude difference		
	$= \frac{90 \times 4}{60} = 6\text{ h}$	M1	
	Local time at C when aircraft reached		
	$\begin{array}{r} 0720 \\ 0600 \\ \hline \end{array}$		
	$\begin{array}{r} 0120 \\ 1040 \\ \hline \end{array}$	M1	
	<u>1200 h</u>	A1	
		10	

No.	Marking scheme	Marks	Comments
21.	(a) $y < 2x$ $\left. \begin{aligned} 3 \times 8 \times x + 2 \times 15 \times y &\geq 240 \\ 24x + 30y &\geq 240 \\ 4x + 5y &\geq 40 \end{aligned} \right\}$ $x \leq 6$	(i) $y < 2x$	B1
		(ii) $4x + 5y \geq 40$	B1
		(iii) $x \leq 6$	B1
(b)		S1	
		B1 \rightarrow $y < 2x$ drawn and correct hand	
		B1 \rightarrow $4x + 5y \geq 40$ drawn and ✓ shaded	
		B1 $x \leq 6$ drawn and ✓ shaded	
(c)	Search line $\left. \begin{aligned} 3 \times 5000 \times x + 2 \times 12500 \times y &= C \\ 15000x + 25000y &= C \\ 15000x + 25000y &= 75000 \\ 3x + 5y &= 15 \end{aligned} \right\}$ For minimum cost, $x = 5, y = 4$ Minimum cost $= 15000 \times 5 + 25000 \times 4$ $= \text{Ksh } 175\,000$		
		B1 Search line drawn	
		B1 \rightarrow at least 3 value among the 4	
		B1 \rightarrow	
		10	

Alternatively (Inspection)
 Must use three points with one of them being (5, 4)
 $x = 5$ and $y = 4$

No.	Marking scheme	Marks	Comments																
22.	<p>(a)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Upper class boundary</td> <td>104.5</td> <td>114.5</td> <td>124.5</td> <td>134.5</td> <td>144.5</td> <td>154.5</td> <td>164.5</td> </tr> <tr> <td>Cumulative frequency</td> <td>7</td> <td>18</td> <td>33</td> <td>45</td> <td>53</td> <td>57</td> <td>60</td> </tr> </table> <p>(b) Q_1 (Blood pressure of 15th patient) = 112 ± 0.5 Q_3 (Blood pressure of 45th patient) = 134.5 ± 0.5 Range = $134.5 - 112$ = 22.5</p> <p>(c) 56th patient is the 1st patient to exceed pressure of 150 No. of patients exceeding pressure of 150 = 5 Percentage = $\frac{5}{60} \times 100$ = $8\frac{1}{3}\%$ $150 = 144.5 + \frac{(n-53)10}{4}$ $n = 55$ $60 - 55 = 5$</p>	Upper class boundary	104.5	114.5	124.5	134.5	144.5	154.5	164.5	Cumulative frequency	7	18	33	45	53	57	60	<p>B1</p> <p>All \checkmark <i>ef</i></p> <p>S1 P1 C1</p> <p>B1</p> <p>M1 A1</p> <p>B1</p> <p>M1 A1</p> <p>10</p>	<p><i>So P₁ Co</i></p> <p><i>104.5</i></p> <p><i>Either Q₁ or Q₃ ✓</i> <i>134.5 is exact</i> <i>if C is less Mo</i></p> <p><i>No decimals</i></p>
Upper class boundary	104.5	114.5	124.5	134.5	144.5	154.5	164.5												
Cumulative frequency	7	18	33	45	53	57	60												

$\frac{5}{60} \times 100 \rightarrow 8\frac{1}{3}\%$

No.	Marking scheme	Marks	Comments
23.	<p>(a)(i) $\angle EAD = 40^\circ$ (\angle in alt. segment) → B1</p> <p>$\angle ADE = 180 - (40 + 45) = 95$ (sum of angle in Δ)</p> <p>$\angle BDE = 40^\circ$ (alternate angle)</p> <p>$\angle ADB = 180 - (95 + 40)$ → M1</p> <p>$= 45^\circ$ → A1</p> <p>(ii) $\angle BAD = 180^\circ - (45^\circ + 40^\circ) = 95^\circ$</p> <p>$\angle BCD = 180^\circ - 95^\circ = 85^\circ$ → B1</p> <p>$\angle BOC = 2 \times 40^\circ$</p> <p>$= 80^\circ$</p> <p>$\angle OCB = \left((180^\circ - 80^\circ) \times \frac{1}{2} \right) = 50^\circ$ → B1 M1</p> <p>$\angle OCD = 85^\circ - 50^\circ = 35^\circ$ → B1 A1</p> <p>(b)(i) $EA = \sqrt{3.5(3.5 + 4.9)} = \sqrt{3.5 \times 8.4}$ → M1</p> <p>$= 5.4 \text{ cm}$ → A1</p> <p>(ii) $2r = \frac{4.9}{\sin 55^\circ}$ → M1</p> <p>$r = 2.991$</p> <p>$r \approx 3.0 \text{ cm}$ → A1</p>	<p>for 80° or 96°</p> <p>$\left(\frac{180 - 110}{2} \right)$</p>	<p>Follow thro'</p>
		10	

No.	Marking scheme	Marks	Comments
24.	(a)(i) Total No. of students = 60 + 56 + 44 + 40 = 200	→ B1	Can be employed in the second?
	$P(\text{Student in } F_4) = \frac{40}{200} = \frac{1}{5}$	→ B1	
	(ii) P (Student wears glasses)		
	$= \frac{\frac{10}{100} \times 60 + \frac{12.5}{100} \times 56 + \frac{25}{100} \times 44 + \frac{17.5}{100} \times 40}{200}$	→ M1	
	$= \frac{6 + 7 + 11 + 7}{200}$		
	$= \frac{31}{200}$	→ A1	0.155
	(b)(i) P (Either F_1F_4 or F_4F_1)		
	$= \frac{60}{200} \times \frac{40}{199} + \frac{40}{200} \times \frac{60}{199}$	M1M1	Any one must be ✓.
	$= \frac{12}{199} + \frac{12}{199}$		
	$\frac{4800}{39800} = \frac{24}{199}$	A1	$\frac{4800}{39800}$
(ii) P (Either F_1GF_4G or F_4GF_1G)			
$= \frac{60}{200} \times \frac{10}{100} \times \frac{40}{199} \times \frac{17.5}{100} + \frac{40}{200} \times \frac{17.5}{100} \times \frac{60}{199} \times \frac{10}{100}$	M1M1	Any of those ✓ probabilities	
$= \frac{21}{19900} + \frac{21}{19900}$			
$\frac{84}{39800} = \frac{42}{19900} = \frac{21}{9950}$	A1	$\frac{42}{39800}$	
		10	

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121/2 MS
MATHEMATICS ALT. A
Paper 2
March 2021
MARKING SCHEME

THE KENYA NATIONAL EXAMINATIONS COUNCIL

Kenya Certificate of Secondary Education

MATHEMATICS Alt. A
Paper 2

MARKING SCHEME
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Turnover