Term 2 - 2022
MATHEMATICS (121/1) –PAPER 1
FORM FOUR (4)
Time: 2 ½ Hours (MARKING SCHEME)

NO.	WORKING	MARKS	REMARKS
1.	$\sqrt[3]{\frac{0.4 \times 1.28 \times 10^3}{0.064 \times 10^3}} = \sqrt[3]{\frac{4 \times 128}{64}}$ $\sqrt[3]{\frac{2^2 \times 2^7}{2^6}}$ $\left(\frac{2^9}{2^6}\right)^{\frac{1}{3}} = (2^3)^{\frac{1}{3}} = 2$	M1 M1 A1	Removal of decimal places Expressing as product of prime factors
	Total	**3**	
2.	$2.\dot{3}\dot{4} = 2.3434343 \ldots = r$ $100r = 234.3434343 \ldots$ $\underline{r = 2.343434 \ldots}$ $99r = 232$ $r = \frac{232}{99}$ Also $1.\dot{9}\dot{1} = 1.919191 \ldots q$ $100q = 191.919191 \ldots$ $\underline{q = 1.919191 \ldots}$ $99q = 190$ $q = \frac{190}{99}$ Hence $\frac{232}{99} - \frac{190}{99}$ $= \frac{42}{99} = \frac{14}{33}$	M1 M1 M1 A1	Expressing $2.\dot{3}\dot{4}$ as a fraction Expressing $1.\dot{9}\dot{1}$ as a fraction Difference between the 2 fractions
	Total	**4**	
3.	$\text{HCF} \rightarrow 7920 = 2^4 \times 3^2 \times 5 \times 11$ $\text{GCD} \rightarrow 12 = 2^2 \times 3$ $48 = 2^4 \times 3$ $264 = 2^3 \times 3 \times 11$ Other number$\rightarrow 2^2 \times 3^2 \times 5 = 180$	M1 M1, A1	Expressing HCF, GCD and the 2 given numbers in power form
	Total	**3**	
4.	From the graph, $x = -3 \rightarrow x + 3 = 0$ and $x = 2 \rightarrow x - 2 = 0$ $(x + 3)(x - 2) = 0$ $x(x - 2) + 3(x - 2) = 0$ $x^2 - 2x + 3x - 6$ $x^2 + x - 6 = 0$ Hence $a = 1, b = 1$ and $k = -6$	M1 A1 B1	Factorization by grouping
	Total	**3**	

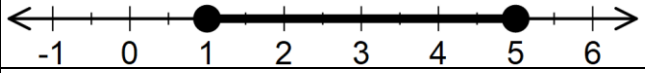
NO.	WORKING	MARKS	REMARKS
5.	$P:Q = 2:3 \ldots \times 4 = 8:12$ $R:Q = 5:4 \ldots \times 3 = 15:12$ Hence $P:Q:R = 8:12:15$ $Q \rightarrow \frac{12}{8+12+15} \times 875$ $Q \rightarrow \frac{12}{35} \times 875 = 300$ bags	 B1 M1 A1	
	Total	**3**	
6.	Curved Surface Area of cylinder $C.S.A = \frac{22}{7} \times 1.02 \times 1.3$ Number of revolutions $= \frac{291.72}{\frac{22}{7} \times 1.02 \times 1.3}$ $= 70$	 M1 M1 A1	
	Total	**3**	
7.	$\text{Cost} \rightarrow \frac{120}{100} \times 5000 = \text{USD } 6000$ $\text{Shipping} \rightarrow \frac{80325}{135} = \text{JPY USD}$ $\text{Total} \rightarrow 6000 + 595 = 6{,}595$ $\text{Total cost} \rightarrow 6{,}595 \times 120$ $= \text{Ksh. } 791{,}400$	 M1 M1 A1	 Total cost in USD Conversion of USD to Ksh
	Total	**3**	
8.	Let $BC = x$ $\tan 40^0 = \frac{AB}{x} \rightarrow AB = x \tan 40^0$ Also $\tan 32^0 = \frac{AB}{x+50} \rightarrow AB = (x+50)\tan 32^0$ $x \tan 40^0 = (x+50)\tan 32^0$ $0.8391x = (x+50)0.6249$ $0.8391x - 0.6249x = 31.245$ $0.2142x = 31.245$ $x = \frac{31.245}{0.2142} = 145.9$ m	 M1 M1 A1	 Expressing AB in terms of $\tan 32^0$ and $\tan 40^0$ Equating AB to AB 145.9 seen
	Total	**3**	
9.	$V = \left\{\frac{1}{2} \times 8(13+20)\right\} \times 12$ $V = 1\,584$ $\text{Mass} = \frac{3.5 \times 1\,584}{1000}$ $= 5.544$ kg	 	
	Total	**3**	

<table>
<tr><th>NO.</th><th>WORKING</th><th>MARKS</th><th>REMARKS</th></tr>
<tr><td>10.</td><td>$3^{2x+2} + 3^{2x} = 810$
$3^2 \times 3^{2x} + 3^{2x} = 810$
$9(3^{2x}) + 3^{2x} = 810$
$10(3^{2x}) = 810 \rightarrow 3^{2x} = 81$
$3^{2x} = 3^4$
$2x = 4 \rightarrow x = 2$</td><td>M1

M1
A1</td><td>Expressing right hand side in terms of base 3</td></tr>
<tr><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>11.</td><td>Let the slant length of the smaller cone be l
$\frac{l}{l+30} = \frac{10}{17.5}$
$17.5l = 10l + 300$
$l = \frac{300}{7.5} = 40$
$\text{C.S.A} = 3.142\{(17.5 \times 70) - (10 \times 40)\}$
$\text{C.S.A} = 2\,592.15\ \text{cm}^2$</td><td>
M1

M1, M1
A1</td><td></td></tr>
<tr><td></td><td>Total</td><td>4</td><td></td></tr>
<tr><td>12.</td><td>$4x - x \leq 6 + 9$
$3x \leq 15 \rightarrow x \leq 5$

$x + 3x \geq 8 - 4$
$4x \geq 4 \rightarrow x \geq 1$

$1 \leq x \leq 5$
 
</td><td>

B1

B1

B1</td><td>

For $x \leq 5$ and $x \geq 1$

Compound inequality shown

Number line drawn</td></tr>
<tr><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>13.</td><td>Frequency distribution table
<table><tr><td>Marks</td><td>f</td></tr><tr><td>10 – 14</td><td>2</td></tr><tr><td>15 – 19</td><td>5</td></tr><tr><td>20 – 24</td><td>7</td></tr><tr><td>25 – 29</td><td>12</td></tr><tr><td>30 – 34</td><td>4</td></tr></table>
$\Sigma f = 2 + 5 + 7 + 12 + 4 = 30$</td><td>
B1

B1

B1</td><td>All classes/class boundaries ✓

All frequencies ✓

Total frequency30 seen</td></tr>
<tr><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>14.</td><td>Logarithms
<table><tr><td>Number</td><td>Std Form</td><td>Logarithm</td></tr><tr><td>7.089</td><td>7.089×10^0</td><td>0.8506</td></tr><tr><td>124.5</td><td>1.245×10^2</td><td>2.0952</td></tr><tr><td></td><td></td><td>2.9458</td></tr><tr><td>86.73</td><td>8.673×10</td><td>1.9382</td></tr><tr><td></td><td></td><td>$1.0076 \div 3$</td></tr><tr><td>2.167</td><td>2.167×10^0</td><td>0.3359</td></tr></table></td><td>M1

M1

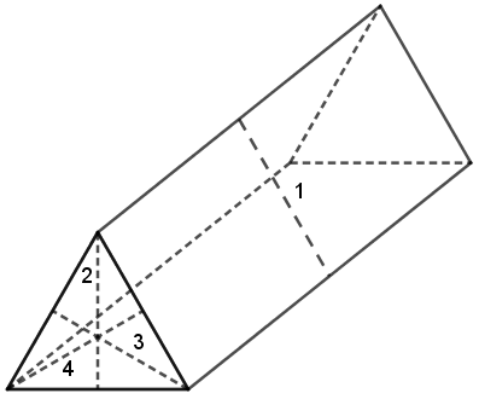
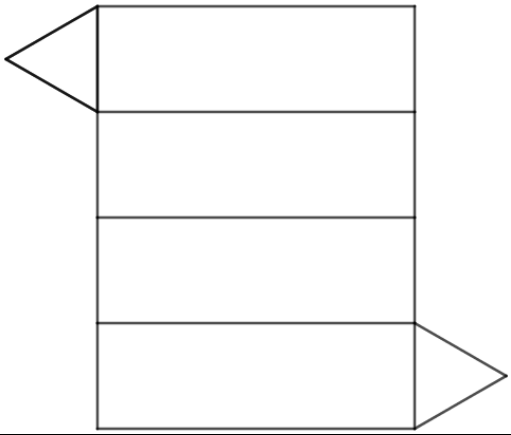
M1

M1</td><td>All logs ✓

Correct +/- of logs

Correct multiplication by 2 and division by 3

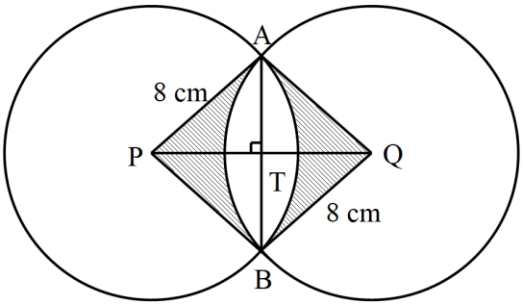
Accuracy</td></tr>
<tr><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

NO.	WORKING	MARKS	REMARKS
15.	Commission $\rightarrow 20\,000 - 12\,400 = 7\,600$ $\frac{2}{100} \times 80\,000 = 1\,600$ $7\,600 - 1\,600 = 6\,000$ $6\,000 = \frac{3}{100} \times A$ $A = 6\,000 \times \frac{100}{3} = 200\,000$ Total value $200\,000 + 80\,000 = 280\,000$	M1 M1 A1	Amount from commission Expression for excess of 80 000
	Total	**3**	
16.	(a) Lines of symmetry  (b) Net 	B1 B1 B1	For all the 4 lines of symmetry drawn Correct net drawn Correct measurements transferred from the solid
	Total	**2**	

NO.	WORKING	MARKS	REMARKS
17.	(a) (i) Equation of l_1		
	$3 = -\frac{1}{2}(-1) + c$	M1	Substituting $(-1, 3)$ in $y = mx + c$
	$6 = 1 + 2c$		
	$2c = 5 \rightarrow c = \frac{5}{2}$		
	$l_1 \rightarrow y = -\frac{1}{2}x + \frac{5}{2}$	A1	$y = -\frac{1}{2}x + \frac{5}{2}$ seen
	(ii) If $S(0, k) \rightarrow S$ – y-intercept		
	$k = \frac{5}{2} = 2.5$	B1	2.5 or equivalent seen
	(b) (i) Gradient of l_2		
	$m_2 = \frac{5-(-3)}{4-1} = \frac{5+3}{3} = \frac{8}{3}$	B1	$\frac{8}{3}$ seen
	(ii) Equation of l_2		
	$\frac{8}{3} = \frac{y-5}{x-4}$	M1	
	$8x - 32 = 3y - 15$		
	$8x - 3y = 17$	A1	
	(c) Equation of l_3		
	$m_3 \times \frac{8}{3} = -1 \rightarrow m_3 = -\frac{3}{8}$	B1	
	$\frac{-3}{8} = \frac{y-5}{x}$	M1	
	$-3x = 8y - 40$		
	$3x + 8y = 40$	A1	
	(d) Acute angle of l_3 and x-axis		
	$\tan\theta = \frac{3}{8}$		
	$\theta = \tan^{-1}\left(\frac{3}{8}\right)$		
	$\theta = 20.56^0$		
	Total	**10**	

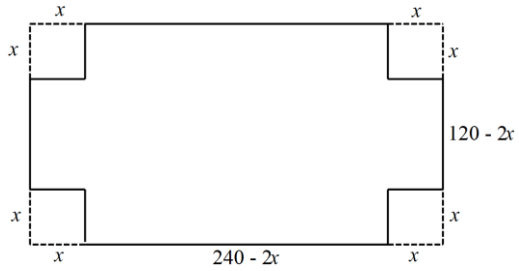
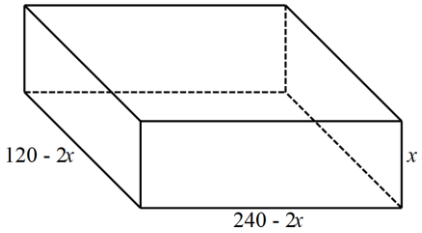
NO.	WORKING	MARKS	REMARKS
18.	(a) Amount of water delivered in 1 minute $V = \frac{22}{7} \times 3.5 \times 3.5 \times 15 \times 100$ $V = 57\ 750$ Capacity $\frac{57\ 750}{1\ 000} = 57.75$ litres	 M1 A1 B1	
	(b) Area of base of tank Time difference 1310 hrs <u>0630 hrs</u> 6 hrs 40 minutes $\rightarrow 6 \times 60 + 40 = 400$ minutes 1 minute $\rightarrow 57.75$ litres 400 minutes $= 400 \times 57.75$ $= 23\ 100$ litres 1 litres $= 1\ 000\ cm^3$ $23\ 100$ litres $= 23\ 100 \times 1\ 000$ $23\ 100 \times 1\ 000 =$ Base Area $\times 12$ Base Area $= \frac{23\ 100 \times 1\ 000}{12 \times 10\ 000}$ $= 192.5\ m^2$	 M1 M1 M1 A1	 Time difference Capacity in 400 minutes Expression for base area
	(c) Monthly water bill 1 000 litres $\rightarrow$ Ksh 100 23 100 litres $= \frac{23\ 100 \times 100}{1\ 000}$ $=$ Ksh 2 310 Bill $2\ 310 + 1\ 950 =$ Ksh 4 260	 M1 M1, A1	
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
19.	(a) $\mathbf{A^{-1}}$ $\det A = 15 \times 8 - 9 \times 12 = 12$ $\mathbf{A^{-1}} = \frac{1}{12}\begin{pmatrix} 15 & -12 \\ -9 & 8 \end{pmatrix} = \begin{pmatrix} 1.25 & -1 \\ -.075 & \frac{2}{3} \end{pmatrix}$	B1	Accept if all elements as fractions
	(b) (i) Equations $8p + 12c = 294\,000$	B1	
	$(8+1)p + (12+3)c = 294\,000 + 43\,500$ $9p + 12c = 337\,500$	B1	
	(ii) Cost of each item $\begin{pmatrix} 8 & 12 \\ 9 & 15 \end{pmatrix}\begin{pmatrix} p \\ c \end{pmatrix} = \begin{pmatrix} 294\,000 \\ 337\,500 \end{pmatrix}$	M1	Matrix equation
	$\begin{pmatrix} 1.25 & -1 \\ -.075 & \frac{2}{3} \end{pmatrix}\begin{pmatrix} 8 & 12 \\ 9 & 15 \end{pmatrix}\begin{pmatrix} p \\ c \end{pmatrix} = \begin{pmatrix} 1.25 & -1 \\ -.075 & \frac{2}{3} \end{pmatrix}\begin{pmatrix} 294\,000 \\ 337\,500 \end{pmatrix}$ $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} p \\ c \end{pmatrix} = \begin{pmatrix} 30\,000 \\ 4\,500 \end{pmatrix}$	M1	Premultiplying by $\mathbf{A^{-1}}$
	$\begin{pmatrix} p \\ c \end{pmatrix} = \begin{pmatrix} 30\,000 \\ 4\,500 \end{pmatrix}$	M1	
	$p =$ Ksh 30 000 $c =$ Ksh 4 500	A1	Both values ✓
	(c) Let the number be ab $a - b = 1$ $(10a + b) + (10b + a) = 165$ $11a + 11b = 165 \rightarrow a + b = 15$	M1	Forming 2 equations in a and b
	$a - b = 1$ $\underline{a + b = 15}$ $2a = 16 \rightarrow a = 8$	M1	Solution for a and b using any method
	$8 - b = 1 \rightarrow b = 8 - 1 = 7$ Hence the number is 87	A1	
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
20.			
	(a) Consider ΔAPT $\text{PT} = \frac{1}{2}\text{PQ} = 6 \text{ cm}$ $\text{AT} = \sqrt{8^2 - 6^2} = 5.291 \text{ cm}$ $\text{AB} = 2 \times 5.291 = 10.58 \text{ cm}$	M1 A1	
	(b) Shaded area Let $\angle\text{APT} = \theta$ in ΔAPT $\cos\theta = \frac{6}{8} \rightarrow \theta = \cos^{-1}\left(\frac{6}{8}\right) = 41.41^0$ $\angle\text{APB} = 2 \times 41.41^0 = 82.82^0$	B1	Angle APT
	Area of segment $\text{A} = \frac{82.82}{360} \times 3.142 \times 8^2 - \frac{1}{2} \times 8 \times 8 \times \sin 82.82^0$ $\text{A} = 46.261 - 31.749$ $\text{A} = 14.512$	M1, M1 A1	Area of sector, area of ΔAPB
	Both segments $14.512 \times 2 = 29.024$	M1	Area of both segments
	Area of APBQ $\text{A} = 2 \times 31.749 = 63.498$	M1	Area of APBQ
	Shaded area$= 63.498 - 29.024$ $= 34.74 \text{ cm}^2$	M1 A1	Shaded Area
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
21.	(a) (i) $\angle$RTP $\angle$RQT$= 180^0 - 100^0 = 80^0$ – opposite angles of cyclic quadrilateral QRST are supplementary $\angle$TQP=$\angle$UPT$= 28^0$ – angle between a chord and a tangent is equal to the angle subtended by the same chord on the circumference of the alternate segment. $\angle$RQP$= 80^0 + 28^0 = 108^0$ Hence $\angle$RTP$= 180^0 - 108^0 = 72^0$ – opposite angles of cyclic quadrilateral QRTP are supplementary	B1 B1 B1	$\angle$RQT $\angle$RQP $\angle$RTP
	(ii) Join O to Q and consider ΔRQO $\angle$RQO$= 50^0$ – base angles of isosceles ΔRQO $\angle$ROQ$= 180^0 - 2 \times 50^0 = 80^0$ – sum of angles in ΔRQO is 180^0 $\angle$RTQ$= \frac{1}{2} \times 80^0 = 40^0$ – angle at the centre is twice angle at the circumference Hence $\angle$QTP$= 72^0 - 40^0 = 32^0$	B1 B1 B1	$\angle$ROQ $\angle$RTQ $\angle$QTP
	(b) Consider $\angle$QPT$= 180^0 - (28^0 + 32^0) = 120^0$ $\angle$TQO$= 80^0 - 50^0 = 30^0$ In ΔQPT $\frac{6}{\sin 32^0} = \frac{\text{QT}}{\sin 120^0}$ $\text{QT} = \frac{6 \sin 120^0}{\sin 32^0} = 9.806$ Let M be the midpoint of QT $\text{MQ} = \frac{1}{2} \times 9.806 = 4.903$ Consider ΔOQM $\cos 30^0 = \frac{\text{OQ}}{4.903}$ $\text{OQ (radius)} = \frac{4.903}{\cos 30^0} = 5.7$ cm	M1 M1 M1 A1	Sine Rule applied Half of QT Attempt to get radius
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
22.	(a) Time		
	Total length $= 40 + 100 + 160 = 300$ m	M1	Total length
	Relative speed$= 60 - 40 = 20$ km/h	M1	Relative speed
	Time $= \frac{0.3}{20} \times 3600$	M1	
	$= 54$ seconds	A1	
	(b) (i) Value of m		
	$180 = \frac{1}{2} \times 15(4 + m)$	M1	Equation distance to area of trapezium
	$180 \times 2 = 15(4 + m)$		
	$\frac{180 \times 2}{15} = 4 + m$	M1	Collecting like terms
	$4 + m = 24 \rightarrow m = 20$ m/s	A1	
	(ii) No acceleration	B1	
	(iii) Deceleration		
	$a = \frac{0 - 20}{60 - 45}$	M1	
	$a = \frac{-20}{15} = -1\frac{1}{3}$ m/s^2		
	Hence, a deceleration of $1\frac{1}{3}$ m/s^2	A1	
	Total	**10**	

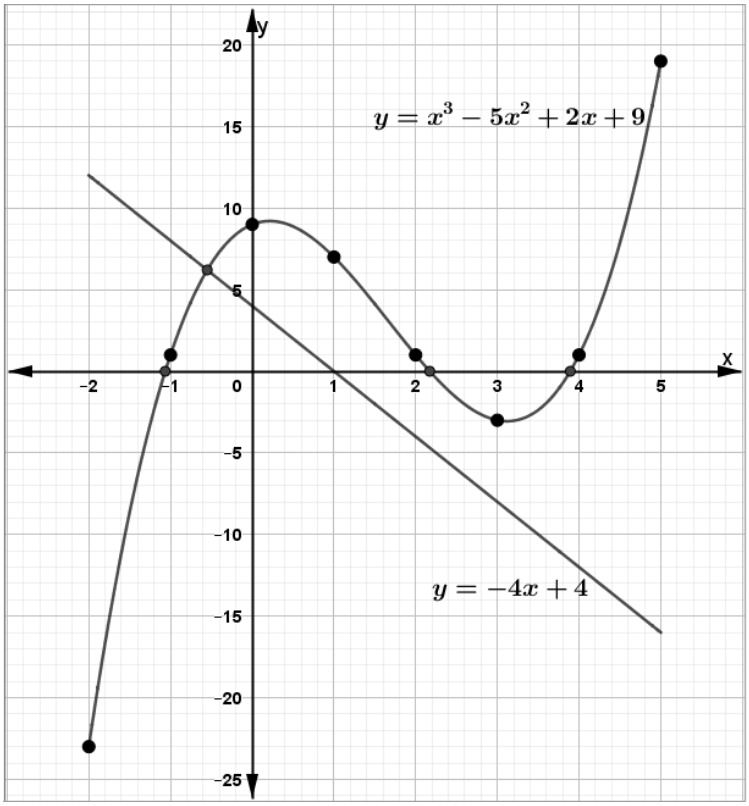
NO.	WORKING	MARKS	REMARKS
23.	(a) Sketch  	B1	Correct sketch
		B1	Dimensions shown on the sketch
	(b) Value of x for maximum volume  		
	$V = (240 - 2x)(120 - 2x)x$ $V = \{240(120 - 2x) - 2x(120 - 2x)\}x$ $V = (4x^2 - 720x + 28800)x$ $V = 4x^3 - 720x^2 + 28800x$	M1	Expression for volume
	$\frac{dV}{dx} = 12x^2 - 1440x + 28800$ For maximum volume $12x^2 - 1440x + 28800 = 0 \rightarrow x^2 - 120x + 2400 = 0$ $x = \frac{-(-120) \pm \sqrt{(-120)^2 - 4 \times 2400}}{2}$ $x = \frac{120 \pm \sqrt{4800}}{2}$ $x = \frac{120 \pm 69.28}{2}$	M1	Equating volume to 0 at maximum volume
	Either $x = \frac{120 + 69.28}{2} = 94.64 \cong 95$ And $x = \frac{120 - 69.28}{2} = 25.36 \approx 25$	A1	Both values of x
	Hence $x = 25$	B1	Value of x
	(c) Mass of empty box External dimensions $(240 - 2 \times 25)$ cm by $(120 - 2 \times 25)$ cm by 25 cm 190 cm by 70 cm by 25 cm		
	Internal dimensions 188 cm by 68 cm by 24 cm $V = (190 \times 70 \times 25) - (188 \times 68 \times 24)$ $V = 332500 - 306816 = 25684$ Mass $= 25684$	M1 M1 A1	Internal and external dimensions

	Total	**10**	
NO.	**WORKING**	**MARKS**	**REMARKS**
24.	(a) Table		

x	-2	-1	0	1	2	3	4	5
y	-23	1	9	7	1	-3	1	19

B2 — All the y values ✓ (B1 for at least 5 y values ✓)

(b) Graph



S1 — Linear scales used on both axes – accommodates all table values

P1 — All points plotted within the graph paper

C1 — Smooth curve drawn

(c) Roots

(i) $x^3 - 5x^2 + 2x + 9 = 0$

$y = x^3 - 5x^2 + 2x + 9$

$\underline{0 = x^3 - 5x^2 + 2x + 9 -}$

$y = 0$

B1 — $y = 0$ shown or implied in the roots

$x = -1.2$ or $x = 2.2$ or $x = 3.8$ – all ± 0.2

B1

(ii) $x^3 - 5x^2 + 6x = -5$

$y = x^3 - 5x^2 + 2x + 9$

$\underline{0 = x^3 - 5x^2 + 6x + 5 -}$

$y = -4x + 4$

M1 — ✓ attempt to get $y = -4x + 4$

L1 — Line $y = -4x + 4$ drawn

$x = -0.6 \pm 0.2$

B1 — ✓ value of x

	Total	**10**	