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MATHEMATICS

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MARK SCHEME

Maximum Mark: 130

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Abbreviations

cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
oe	or equivalent
SC	Special Case
nfww	not from wrong working
soi	seen or implied

Question	Answer	Marks	Partial marks
1(a)(i)	4 : 5	1	
1(a)(ii)	4 : 5	1	
1(a)(iii)	3 : 4	2	B1 for 12 : 16 or answer 4 : 3
1(b)(i)	26.8 or 26.79...	3	M2 for $\frac{15600 - 11420}{15600} [\times 100]$ or $\frac{11420}{15600} \times 100$ or M1 for $\frac{11420}{15600}$
1(b)(ii)	16 000 nfww	3	M2 for $15600 \times \frac{100}{100 - 2.5}$ oe or M1 for 15600 associated with 97.5[%] seen
1(c)	1.6 or $\frac{8}{5}$	2	M1 for $\frac{200 \times x \times 15}{100} = 48$ oe or M1 for figs 16
1(d)	2.5 or $\frac{5}{2}$ cao nfww	3	B2 for 2.49[9...] or 102.4[99...] or 1.024[99...] or 2.50 or 102.5 or 1.025 or M2 for $\sqrt[10]{\frac{256}{200}}$ oe or M1 for $256 = 200(x)^{10}$ seen

Question	Answer	Marks	Partial marks
2(a)(i)	1070 or 1072. ...	3	M1 for $\pi \times 8^2 \times 2 \times 8$ M1 for $\frac{4}{3} \times \pi \times 8^3$ or M2 for $\frac{2}{3} \pi r^3$ or M1 for $\pi r^2 2r - \frac{4}{3} \pi r^3$
2(a)(ii)	2.58 or 2.580 to 2.581	3	B2 for $r^3 = \frac{36 \times 3}{2\pi}$ or better or M1 for $\pi \times r^2 \times 2 \times r - \frac{4}{3} \times \pi \times r^3 = 36$ oe
2(b)(i)	4.24 or 4.241 to 4.242	4	M3 for $(\pi \times 5^2 + \pi \times 5 \times \sqrt{5^2 + 12^2})$ or M2 for $\pi \times 5 \times \sqrt{5^2 + 12^2}$ or M1 for $5^2 + 12^2$ or $\pi \times 5^2$
2(b)(ii)	64 cao final answer	3	M2 for $\frac{[k\pi] \times 5^2 \times 12}{[k\pi] \times 1.25^2 \times 3}$ or M1 for $\frac{1}{3} \times \pi \times 5^2 \times 12$ or $\frac{1}{3} \times \pi \times 1.25^2 \times 3$ OR M2 for 4^3 or $\left(\frac{1}{4}\right)^3$ seen or M1 for factor 4 or $\frac{1}{4}$ soi
3(a)	7040 or 7035. ...	3	M1 for $\frac{1}{2} \times 100 \times 70$ oe M1 for $\frac{1}{2} \times 100 \times 110 \times \sin 40$ oe
3(b)	374 or 375 or 374.4 to 374.5....	5	M2 for $110^2 + 100^2 - 2 \times 110 \times 100 \times \cos 40$ oe or M1 for implicit form A1 for 5250 or 5247. ... (or 72.4 or 72.43 to 72.44) M1 for $70^2 + 100^2$
3(c)	64.3 or 64.27 to 64.28 nfww	2	M1 for $\sin 40 = \frac{\text{distance}}{100}$ oe
3(d)	235	3	B2 for [angle $ACB =$] 34.99 to 35 or [angle $ABC =$] 55[.0...] or M1 for $\tan[ACB] = \frac{70}{100}$ or $\tan[ABC] = \frac{100}{70}$ or equivalent trig ratio

Question	Answer	Marks	Partial marks
4(a)(i)	Correct translation	2	B1 for translation $\begin{pmatrix} 6 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -2 \end{pmatrix}$
4(a)(ii)	Correct rotation	2	B1 for rotation 180° but other centre
4(a)(iii)	Correct reflection	2	B1 for reflection in $y = -x$
4(b)(i)	Enlargement [factor] $\frac{1}{2}$ or 0.5 [centre] (0, 0) oe	3	B1 for each
4(b)(ii)	$\begin{pmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{pmatrix}$ oe	2	B1 for matrix of form $\begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix}$ oe, $k \neq 0$ or 1
4(c)	± 2.5	3	B2 for $25u^2 = 156.25$ or $5u = [\pm]12.5$ or M1 for $(4u)^2 + (3u)^2$
5(a)	3.2 or 3.15 or 3.152 to 3.153 5.2 or 5.19 or 5.20 or 5.196...	2	B1 for each
5(b)	Correct graph for $0.5 \leq x \leq 3.5$	4	B3FT for 6 or 7 correct points or B2FT for 4 or 5 correct points or B1FT for 2 or 3 correct points
5(c)	1.7 to 1.8	1FT	FT <i>their</i> graph if one answer
5(d)(i)	Any integer $k \geq -1$	1	
5(d)(ii)	Any integer $k < -1$	1	
5(e)	Tangent ruled at $x = -3$	B1	
	2.5 to 4	B2	dep on tangent drawn at $x = -3$ or close attempt at tangent at $x = -3$ M1 for rise/run also dep on tangent at $x = -3$ or close attempt at tangent at $x = -3$

Question	Answer	Marks	Partial marks
5(f)(i)	$y = 6 - x$ ruled accurately	M2	M1 for correct line but freehand or ruled line gradient -1.1 to -0.9 , or through $(0, 6)$ but not $y = 6$
	$2.85 \leq x \leq 3$	A1	
5(f)(ii)	$[a =] 8$ $[b =] -48$ $[c =] -16$	4	B3 for 2 correct or $x^5 + 8x^3 - 48x^2 - 16 = 0$ seen or $-x^5 - 8x^3 + 48x^2 + 16 = 0$ seen or M2 for correct multiplication by $8x^2$ or B1 for answers $\pm 8, \pm 48, \pm 16$ or M1 for $\frac{x^2 \times x^3 - 8 \times 2}{x^2 \times 8} = 6 - x$ or M1 for correct multiplication by 8 or M1 for correct multiplication by x^2
6(a)(i)	280	1	
6(a)(ii)	320	1	
6(a)(iii)	90	1	
6(a)(iv)	10	2	M1 for 90 written
6(b)(i)	250.2 nfwf cao	4	M1 for at least 4 correct mid-values M1 for Σfx M1 dep on second M1 for $\Sigma fx \div 100$
6(b)(ii)	Correct completion of histogram	4	B1 for each correct block If zero scored, then SC1 for correct frequency densities seen
6(c)	[22 m] further oe	1	
7(a)	$\frac{5}{6}$	1	
7(b)	$\frac{4}{36}$ oe	2	M1 for $\frac{2}{6} \times \frac{2}{6}$
7(c)	20	1	

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Question	Answer	Marks	Partial marks
7(d)(i)	Diagram completed correctly $\begin{array}{ccccccc} \times & \times & 3 & 3 & 3 & 9 \\ \times & \times & 2 & 2 & 2 & 6 \\ \times & \times & 2 & 2 & 2 & 6 \\ \times & \times & 2 & 2 & 2 & 6 \\ \times & \times & 1 & 1 & 1 & 3 \end{array}$	2	B1 for 3 correct columns or for 4 correct rows
7(d)(ii)(a)	$\frac{9}{36}$ oe	1FT	FT <i>their (d)(i)</i>
7(d)(ii)(b)	$\frac{4}{36}$ oe	1FT	FT <i>their (d)(i)</i>
7(e)	$\frac{512}{7776}$ oe	2	M1 for $\left(\frac{4}{6}\right)^k \times \frac{2}{6}$ oe $k = 3, 4$ or 5 only
8(a)(i)	$7a + 9p = 354$ oe final answer	1	
8(a)(ii)	$[a =] 21$ $[p =] 23$	3	M1 for correctly eliminating one variable A1 for $a = 21$ A1 for $p = 23$
8(b)(i)	$\frac{2}{x}$	1	
8(b)(ii)(a)	$\frac{2}{x} + \frac{3}{x-1} = 2$	M1	
	$2(x-1) + 3x = 2x(x-1)$ oe	M1dep	Both sides of the equation could be over $x(x-1)$ at this stage Dep on M1 or 3 term equation with fractions but one sign error
	$2x - 2 + 3x = 2x^2 - 2x$ oe $2x^2 - 7x + 2 = 0$	A1	Answer reached with one correctly expanded line seen and no errors seen
8(b)(ii)(b)	$\sqrt{(-7)^2 - 4(2)(2)}$	B1	or for $\left(x - \frac{7}{4}\right)^2$
	$\frac{- -7 + \sqrt{q}}{2 \times 2}$ or $\frac{- -7 - \sqrt{q}}{2 \times 2}$	B1	or for $\frac{7}{4} + \text{or} - \sqrt{-1 + \left(\frac{7}{4}\right)^2}$
	3.19 only	B2	B1 for 3.19 with other root or for 3.2 or 3.186... isw other root or for 0.31 or 0.314 or 0.3138 to 0.3139

Question	Answer	Marks	Partial marks
9(a)	3	1	
9(b)	$-\frac{2}{5}$ oe	2	M1 for $2(1-2x) = x+4$
9(c)	$-2x-7$ final answer	2	M1 for $1-2(x+4)$
9(d)	26	2	B1 for $h(5)$ soi or M1 for $(x^2+1)^2+1$
9(e)	$\frac{1-x}{2}$ oe final answer	2	M1 for $x=1-2y$ or $2x=1-y$ or $\frac{y}{2}=\frac{1}{2}-x$ or $y-1=-2x$
9(f)	$[p=]-20$ $[q=]26$	4	B3 for $[hgf(x)] = 4x^2 - 20x + 26$ seen and not spoilt by further working or M1 for $(1-2x)+4$ M1 dep for $(their (5-2x))^2+1$ B1FT dep for $25-10x-10x+4x^2$
10(a)	5.68 or 5.684 to 5.685	5	M2 for $2x\sqrt{x^2+x^2}$ oe or $2\times\sqrt{2}\times x^2$ or M1 for $x\sqrt{2}$ or $\sqrt{x^2+x^2}$ oe soi M1 for $\frac{270}{360}\times\pi\times x^2$ oe M1 for $0.5x^2$ oe
10(b)	4.4[0] or 4.398 to 4.401	2	dep on a correct value for k in (a) M1 for $[x^2]=\frac{110}{their k}$