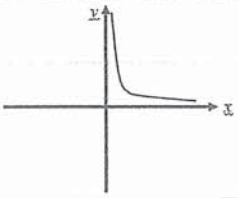
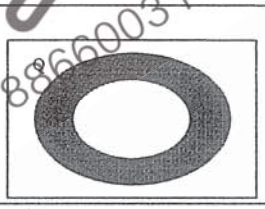
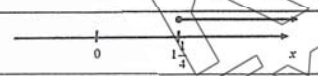
Name: _____ ( ) Class: _____

2019 Sec 4Exp/5NA Preliminary Examination
Mathematics Paper 1
Answer Key

1a	$2^2 \times 3^3 \times 5 \times 7$	**1b**	105	**2a**	(28.5)
2b	$\begin{pmatrix} 7 & 14 \\ -7 & -14 \end{pmatrix}$	**3a**	x = -4	**3b**	k = 0
4	80%	**5a**	Charlene should use **Graph 2** as the **scale for the vertical axis is bigger and does not start from zero,** making the **difference in marks** between each test looks **bigger.**	**6a**	2.325×10^{-7} picograms
6b	2.86×10^{-5} : 1	**7a**	– 17 °C	**7b**	2100 m
7c	05 42	**8a**		**8b**	$P=\frac{32}{12}=2.67Nm^{-2} or 2\frac{2}{3}Nm^{-2}$
9a	7.56 km	**9b**	2.71 cm^2 (3 s.f.)	**10a**	$1+3+5+7+9+11+13=49=7\times7$
10b	$1+3+5+7+9+\ldots+81=41\times41=1681$	**11**	\$2155.06 (2 d.p)	**12a**	B
12b	D	**12c**	C	**13a**	
13bi	{2,3,7,11,13,17,19}	**13bii**	3	**14a**	$x\geq1\frac{1}{4}$
14b		**15a**	$(x-4.5)^2-24.75$	**15b**	25.28 or 15.23 (2 d.p.)
16a	$\frac{17}{13}$	**16b**	$\frac{216}{75}$	**17a**	$2(a-7x)(2a+b)$
17b	x = - 5	**18a**	The object is moving at **constant speed of 5 ms^{-1} with zero acceleration** for the first 4 sec	**18b**	7 sec
19c	10.0 ±0.1 cm	**20bi**	$\frac{11}{36}$	**20bii**	$\frac{7}{12}$
21a	a – 4	**21b**	$x=\frac{6}{7}$	**22a**	$y=12$
22b	7	**22c**	3.55	**23a**	168°
23c	36°	**24a**	$13y^2-8y$	**24b**	$\frac{41-18y}{(7+3y)(7-3y)}$

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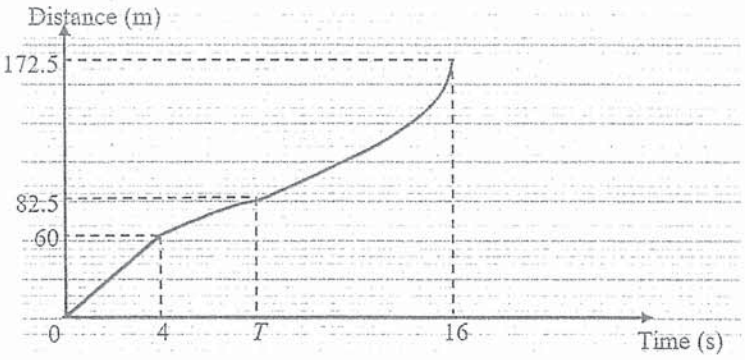
18c



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Marking Scheme for Sec 4 Exp/ 5NA Mathematics P1 2019

Qn	Solution	Marking Scheme
1a	$3780 = 2^2 \times 3^3 \times 5 \times 7$	B1
1b	$2^2 \times 3^3 \times 5 \times 7 \times (3 \times 5 \times 7)$ = perfect sq. Therefore, $3 \times 5 \times 7 = 105$	B1
2a	$\frac{1}{2}BA$ $= \frac{1}{2}\begin{pmatrix}-3 & 9\end{pmatrix}\begin{pmatrix}2\\7\end{pmatrix}$ $= \frac{1}{2}(57)$ $= (28.5)$	B1
2b	C^2 $= \begin{pmatrix}3 & 2\\-1 & 4\end{pmatrix}\begin{pmatrix}3 & 2\\-1 & 4\end{pmatrix}$ $= \begin{pmatrix}7 & 14\\-7 & -14\end{pmatrix}$	B1
3a	$x = -4$	B1
3b	$\frac{1+(-k)}{2} = -4$ $1-k = -8$ $-k = -8-1$ $k = 9$	B1
4	$V = kr^2h$ new radius, $r_1 = 1.5r$, new height, $h_1 = 0.8h$ $V = kr^2h$ $V_{new} = k(1.5r)^2(0.8h)$ $V_{new} = \frac{V}{r^2h}(1.5r)^2(0.8h)$ $\therefore V_{new} = 1.8V$ % change in V $= \frac{1.8-1}{1} \times 100\%$ $= 80\%$	M1 B1 or B2
5	Charlene should use **Graph 2** as the **scale for the vertical axis is bigger and does not start from zero,** making the **difference in marks** between each test looks **bigger.**	A1 B1

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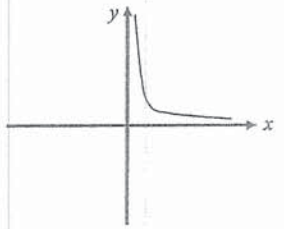
6a	Mass of 12 billion nitrogen atoms $= 2.80\times10^{-9}$ g $= 2.80\times10^{3}$ picograms Mass of 1 nitrogen atom $= \frac{2.80\times10^{3}}{12\times10^{9}}$ $= 0.2325\times10^{-6}$ $= 2.325\times10^{-7}$ picograms	B1
6b	Helium : nitrogen 6.684×10^{-24} : $\frac{2.80\times10^{-9}}{12\times10^{7}}$ 6.684×10^{-24} : 0.2333×10^{-16} 28.6×10^{-6} : 1 2.86×10^{-5} : 1	M1 A1
7a	No. of times temp will decrease $= 4200 \div 700 = 6$ Amt. of decrease In temp. $= 8 \times 6 = 48$°C Temp. at the peak of mountain $= 31 - 48 = -17$ °C	B1
7b	Amt. of decrease in temp. $= 31 - 7 = 24$ °C Height of mountain $= 24 \div 8 \times 700$ m $= 2100$ m	B1
7c	Time he begins his climb $= 12\ 25$ $-\ 6\ 43$ $05\ \ 42$	B1
8a		B1 (Negative region of the reciprocal graph should not be shown as its not applicable)
8b	$P = \frac{k}{V}$ $k = PV$ $= 4(8) = 32$ $\therefore P = \frac{32}{12} = 2.67 Nm^{-2}$ or $2\frac{2}{3} Nm^{-2}$	B1

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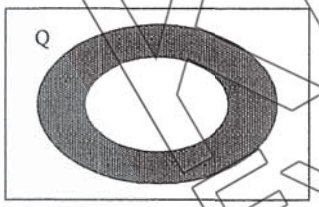
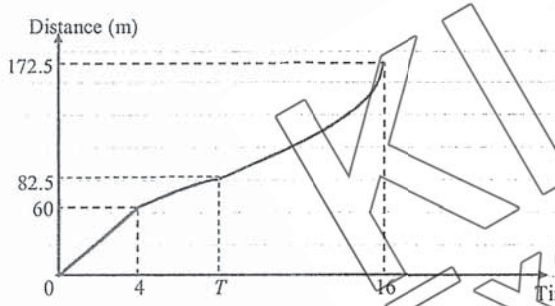
9a	1 cm : 120 000 cm 1 cm : $\frac{120000}{1000\times100}=1.2$km 6.3 cm : 6.3×1.2 km $= 7.56$ km	B1
9b	$(1\text{ cm})^2$: $(1.2\text{ km})^2$ 1 cm^2 : 1.44 km^2 $\frac{3.9}{1.44}\times1$: 3.9 km^2 $2.71\text{ cm}^2=$ (3 s.f.)	M1 A1
10a	$1+3+5+7+9+11+13=49=7\times7$	B1
10b	$1+3+5+7+9+\ldots+81=41\times41=1681$	B1
11	$T=P(1+\frac{r}{100})^n$ $=10000(1+\frac{\frac{10}{2}}{100})^{2\times2}$ $=\$12155.0625$ *Interest* $=\$12155.0625-\$10000$ $=\$2155.06(2d.p.)$	M1 M1 A1
12a	B	B1
12b	D	B1
12c	C	B1
13a	*Answer* ε 	B1
13bi	{2,3,7,11,13,17,19}	B1
13bii	3	B1

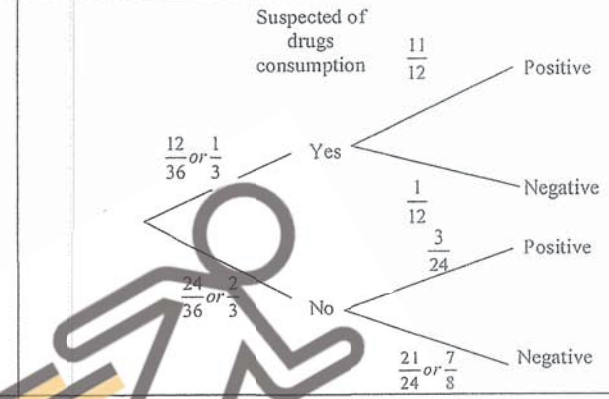
Name: ( ) Class:

14a	$4-3x\le\frac{2-x}{3}<\frac{4+x}{5}$ $4-3x\le\frac{2-x}{3}$ or $\frac{2-x}{3}<\frac{4+x}{5}$ $-9x+x\le2-12$ $\quad -5x-3x<12-10$ $-8x\le-10$ $\quad -8x<2$ $x\ge1\frac{1}{4}$ $\quad x>-\frac{1}{4}$ $\therefore x\ge1\frac{1}{4}$	M1 A1
14b		B1
15a	$x^2-9x+45$ $=x^2-9x+\left(\frac{9}{2}\right)^2-\left(\frac{9}{2}\right)^2+45$ $=(x-4.5)^2+24.75$	B1
15b	$(x-4.5)^2=\pm\sqrt{50-24.75}$ $x-20.25=\pm5.024938$ $x=5.024938+20.25$ or $-5.024938+20.25$ $=25.28$ (2 d.p.) or 15.28 (2 d.p)	M1 A1 for both correct answers
16a	Length of base of triangle $=\sqrt{13^2-5^2}=12$ units $\sin\angle A-\cos\angle A$ $=\sin\angle A-(-\cos(180°-\angle A))$ $=\frac{5}{13}-\left(-\frac{12}{13}\right)$ $=\frac{17}{13}$	 M1 A1
16b	$\cos(180°-\angle A)+\tan(\angle A-90°)$ $=\frac{12}{13}+\tan[180°-(180°-\angle A)-90°]$ $=\frac{12}{13}+\frac{12}{5}$ $=\frac{216}{75}$	 M1 A1

Name: ( ) Class:

17a	$4a^2+2ab-14xb-28ax$ $=2a(2a+b)-14x(b+2a)$ $=(2a-14x)(2a+b)$ $=2(a-7x)(2a+b)$	M1 A1
17b	$\frac{3x+1}{7}=-\frac{3-x}{4}$ $4(3x+1)=-7(3-x)$ $12x+4=-21+7x$ $12x-7x=-21-4$ $5x=-25$ $x=-5$	M1 A1
18a	The object is moving at **constant speed of 5 ms^{-1} with zero acceleration** for the first 4 sec	B1
18b	Gradient = 5 $\frac{15}{Time}=5$ $Time=\frac{15}{5}$ $=3\text{sec}$ $T=4+3=7\text{sec}$	 B1
18c		All 3 parts of correct graph shape = B2 1 wrong shape = deduct B1 2 or more wrong shape = 0 marks
19a,b,	Refer to last page for the details	[2N1]
19c	10.0 ± 0.1 cm	B1

Name: ( ) Class:

20a		Any 2 correct ans = B1 × 2 = B2
20bi	P(suspected of taking drugs and tested positive) $=\frac{12}{36}\times\frac{11}{12}$ $=\frac{11}{36}$	B1
20bii	P(received negative results) $=(\frac{12}{36}\times\frac{1}{12})+(\frac{24}{36}\times\frac{21}{24})$ $=\frac{1}{36}+\frac{7}{12}$ $=\frac{21}{36}$ $=\frac{7}{12}$	M1 A1
21a	$\left(\frac{a^4-a^3}{a^3}\right)-3(a)^0$ $=a^3\left(\frac{a-1}{a^3}\right)-3$ $=(a-1)-3$ $=a-4$	 M1 A1

21b	$\frac{1}{(3^2)^{1-3x}} = (3^5)^{\frac{x}{2}-1}$ $(3^2)^{3x-1} = 3^{\frac{5x}{2}-5}$ $6x-2 = \frac{5x}{2}-5$ $6x-\frac{5x}{2} = -5+2$ $3.5x = -3$ $x = \frac{-3}{3.5}$ $x = \frac{6}{7}$	M1 M1 A1
22a	Let x = 9 as mode is 9 $\text{mean} = \frac{5+6+7+9+2+4+9+12+2+9+y}{11}$ $7 = \frac{65+y}{11}$ $77 = 65+y$ $y = 77-65$ $y = 12$	B1 B1
22b	Median position = $\frac{11+1}{2} = 6th$ Arranging the values in ascending order, 2, 2, 4, 5, 6, 7, 9, 9, 9, 12, 12 Hence the median at 6th position is 7	B1
22c	Standard deviation = 3.55	B2
23a	Int angle *IGH* $= \frac{180°}{3}$(angle in equilateral triangle) $= 60°$ Angle in pentagon $= \frac{(5-2)\times 180°}{5}$ $= 108°$ Angle EDH = 60° + 108° = 168°	M1 A1
23b	Since the triangle is equilateral and all triangles are identical, AB = BC = AC = AI. Hence AI = AB	B1

23c	Angle GEI = Angle CEA $= \frac{180°-108}{2}$(base angles in isos.triangle) $= 36°$ $\therefore \angle AEI = 108° - (36°\times 2)$ $= 36°$	M1 A1
24a	$y(y-2)+12y^2-6y$ $= y^2-2y+12y^2-6y$ $= 13y^2-8y$	M1 for correct expansion A1
24b	$\frac{6}{3y+7} - \frac{1}{49-9y^2}$ $= \frac{6}{3y+7} - \frac{1}{7^2-(3y)^2}$ $= \frac{6}{3y+7} - \frac{1}{(7+3y)(7-3y)}$ $= \frac{6(7-3y)-1}{(7+3y)(7-3y)}$ $= \frac{42-18y-1}{(7+3y)(7-3y)}$ $= \frac{41-18y}{(7+3y)(7-3y)}$	M1 M1 A1

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Fairfield Methodist School (Secondary)
2019 Sec 4Exp/5NA Preliminary Examination
Answer Key for Mathematics Paper 1

Answer Key			
1(a)	$\frac{3x^2+14x-6}{(x-3)(x+4)}$	1(b)	$16(x^2+1)$ or $16x^2+16$
1(c)	$x=0$ or $x=-1.5$ or $x=8$	1(d)	Since $(n+1)^2=(n+1)(n+1)$, therefore, it is a square number. Or $(n+1)^2$ has a repeated same factor, therefore it is a square number.
2(i)	Statement with reasons for SAA/RHS/SAS/SSS	2(ii)	Triangle QUS
2(iii)	Angle TQS = Angle SUT (Angle in same segment) = 60° (mentioned in (i) that triangle QTR is equilateral triangle) Angle QTR = 60° (triangle QTR is an equilateral triangle). Since angle QTR = Angle SUR, the form alternate angle, therefore TQ is parallel to SU. Or Angle TQU = Angle SUQ = 90° (Angle in a semi-circle) Since they are the same and they form interior angle, therefore, TQ is parallel to SU. Or by converse of property of interior angle, therefore TQ is parallel to SU.		
2(iv)	30°	3(c)(i)	$x=9.17$ or $x=0.33$ (2 d.p.)
3(c)(ii)	When $x=0.327$, $DC=2x-5=-4.356<0$. Therefore, x cannot be 0.33.	3(d)	6.35 (3 s.f.)
4(a)	264 cm^2 (nearest cm^2)	4(b)(i)	28
4(b)(ii)	333 cm^3 (nearest cm^3)	4(b)(iii)	184 mm (nearest mm)
4(c)	8: 27	5(a)	132°
5(b)	48.8 m (3 s.f.)	5(c)	h = 32.6 m (3 s.f.)
5(d)(i)	14.0 m (3 s.f.)	5(d)(ii)	23.2°
6(a)	$p=12$	6(c)(i)	Accept answers: -0.023 to – 0.03
6(c)(ii)	The gradient represent the rate of decrease of the cost of printing each book when number of books is 300. Or The gradient represent the rate at which the cost of printing each book is decreasing.	6(d)(i)	Plot points (0, 25), (600, 15) and (1200, 5) Draw a line
6(d)(ii)	$210 \le x \le 700$ (accept 180 – 220; 680 – 730, with interval of 10)	7(a)(i)	Angle APC = 90° (tangent perpendicular radius) Angle AQE = 90°(tangent perpendicular radius) Therefore, angle APC = angle AQE Angle PAC = Angle QAE (common angle) Since there are two pairs of corresponding angles are equal, triangle APC and triangle AQE are similar.
7(a)(ii)	$AB=2$	7(b)	$\angle CAP=\sin^{-1}\left(\frac{1}{2}\right)=30°=\frac{\pi}{6}$
7(c)	17.4 cm (3 s.f.)	8(a)(i)(a)	$12p$

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Answer Key			
8(a)(i)(b)	$2\boldsymbol{p} + 5\boldsymbol{q}$	8(a)(ii)(a)	3 : 10
8(a)(ii)(b)	$\frac{80}{3}$ units^2 or $26\frac{2}{3}$ or 26.7 (3 s.f)	8(a)(iii)	$\frac{15}{2}(2\boldsymbol{p} + \boldsymbol{q})$
8(b)(i)	$\overrightarrow{AB} = \begin{pmatrix} 10 \\ -16 \end{pmatrix}$	8(b)(ii)	58.0° (1 d.p.)
8(b)(iii)	$\overrightarrow{AB} = k\begin{pmatrix} n \\ -2m \end{pmatrix}$ or $\overrightarrow{AB} = k\begin{pmatrix} -n \\ 2m \end{pmatrix}$	8(b)(iv)	$\begin{pmatrix} -30 \\ 48 \end{pmatrix}$
9(a)(i)	41 minutes	9(a)(ii)	25 minutes
9(a)(iii)	IQR = 48 – 29 = 19 mins	9(a)(iv)	$36\frac{2}{3}\%$ *or* $\frac{110}{3}\%$ or 36.7% (3 s.f.)
9(b)	The travelling time using train is much shorter (faster) than using a bus as the median time travelling with a train < median time travelling with a bus. The travelling time using train is less spread out (more consistent) than using travelling using a bus as the interquartile range of travelling time of a train < interquartile range of travelling time of a bus.	9(c)(i)	$\frac{7}{240}$
9(c)(ii)	$\frac{37}{120}$	10(a)(ii)	53.03 m (2 d.p.)
10(a)(iii)	Using staggered start, each runner runs exactly 400 meters or same distance.	10(b)	His claim in false.

Preliminary Examination 2019
Mathematics Paper 2
Marking Scheme

No	Description	Marks	Total
1(a)	$\frac{3x}{x-3}+\frac{2}{x+4}$ $=\frac{3x(x+4)+2(x-3)}{(x-3)(x+4)}$ $=\frac{3x^2+12x+2x-6}{(x-3)(x+4)}$ $=\frac{3x^2+14x-6}{(x-3)(x+4)}$	M1 A1	2
1(b)	$(x^2+5)^2-(x^2-3)^2$ $=[x^2+5-(x^2-3)][x^2+5+(x^2-3)]$ $=(8)(2x^2+2)$ $=16(x^2+1)$ or $16x^2+16$	M1 A1	2
1(c)	$2x^3-13x^2-24x=0$ $x(2x^2-13x-24)=0$ $x(2x+3)(x-8)=0$ $x=0$ or $x=-1.5$ or $x=8$	 M1 A1 (two correct), A1	3
1(d)	$\frac{1}{2}n(n+1)+\frac{1}{2}(n+1)(n+2)$ $=\frac{1}{2}(n+1)[n+n+2]$ $=\frac{1}{2}(n+1)[2n+2]$ $=\frac{1}{2}(n+1)[2(n+1)]$ $=(n+1)^2$ Since $(n+1)^2=(n+1)(n+1)$, therefore, it is a square number. Or $(n+1)^2$ has a repeated same factor, therefore it is a square number.	 B1 B1	2
			8
2(i)	$QR=QT=RT$ (radius of circles centred at Q and R) Therefore, triangle QRT is an equilateral triangle. Angle Q = Angle R = Angle T = 60° $\angle QUT = 30°$ ($\angle$ at centre = $2\times\angle$ at circumference) $\angle TPR = 30°$ ($\angle$ at centre = $2\times\angle$ at circumference) Therefore, angle QUT = angle TPR Therefore, by SAA / AAS, triangle PTR and UQT are congruent.	B1 B1 B1	3

No	Description	Marks	Total
2(i)	Angle $PTR = 90°$ (right angle in semi-circle) Angle $UQT = 90°$ (right angle in semi-circle) Therefore, angle PTR = angle UQT $PR = UT$ (as both are diameter of the circle centred at Q and R respectively) $QR = QT = RT$ (radius of circles centred at Q and R) Therefore, by RHS congruency test, triangle PTR and UQT are congruent.	 B1 B1 B1	
	$PR = UT$ (as both are diameter of the circle centred at Q and R respectively) $QR = QT = RT$ (radius of circles centred at Q and R) Therefore, triangle QRT is an equilateral triangle. Angle Q = Angle R = Angle T = 60° Therefore, by SAS congruency test, triangle PTR and UQT are congruent.	B1 B1 B1	
	Angle $PTR = 90°$ (right angle in semi-circle) Angle $UQT = 90°$ (right angle in semi-circle) Therefore, angle PTR = angle UQT $PR = UT$ (as both are diameter of the circle centred at Q and R respectively) $QR = QT = RT$ (radius of circles centred at Q and R) Therefore, triangle QRT is an equilateral triangle. Angle Q = Angle R = Angle T = 60° Angle PRT = 60° (int angle of equilateral triangle) Angle UTQ = 60° (int angle of equilateral triangle) Therefore, angle PRT = angle UTQ Therefore, by SAA / AAS congruency test, triangle PTR and UQT are congruent.	B1 B1 B1	
2(ii)	Triangle QUS	B1	1
2(iii)	Angle TQS = Angle SUT (Angle in same segment) = 60° (mentioned in (i) that triangle QTR is equilateral triangle) Angle QTR = 60° (triangle QTR is an equilateral triangle). Since angle QTR = Angle SUR, the form alternate angle, therefore TQ is parallel to SU. Since angle QTR = Angle SUR, by converse property of alternate angle, TQ is parallel to SU.	 B1	
	Angle TQU = Angle SUQ = 90° (right angle in a semi-circle) Since they are the same and they form interior angle, therefore, TQ is parallel to SU. Since angle TQU = Angle SUQ, by converse property of interior angle, TQ is parallel to SU.	B1	1
2(iv)	Angle $UQR = 30°$ (angle at circumference = $\frac{1}{2}$ angle at centre) Or Angle $UQR = 30°$ (complementary angle and angle in semicircle)	B1	1
			6

No	Description	Marks	Total
3(a)	$\frac{Area\ of\ triangle\ CDE}{Area\ of\ triangle\ ABC}$ $=\frac{\frac{1}{2}\times CD\times CE\times sin\theta}{\frac{1}{2}\times AC\times BC\times sin\theta}$ $=\frac{CD\times CE}{AC\times BC}$	M1 AG1	2
3(b)	$\frac{CD\times CE}{AC\times BC}=\frac{1}{3}$ $\frac{(2x-5)\times x}{(12+x)\times(4+2x-5)}=\frac{1}{3}$ $3x(2x-5)=(12+x)(2x-1)$ $6x^2-15x=24x-12+2x^2-x$ $4x^2-15x-24x+x+12=0$ $4x^2-38x+12=0$ $2(2x^2-19x+6)=0$ $2x^2-19x+6=0$	M1 M1 (Expand and simplify) AG1	3
3(c)(i)	$2x^2-19x+6=0$ $x=\frac{19\pm\sqrt{(-19)^2-4(2)(6)}}{2(2)}$ $x=\frac{19\pm\sqrt{313}}{4}$ $x=9.1729$ or $x=0.3270484$ $x=9.17$ or $x=0.33$ (2 d.p.)	M1 A1, A1	3
3(c)(ii)	When $x=0.327$, $DC=2x-5=-4.356<0$. Therefore, x cannot be 0.33.	B1	1
3(d)	When $x=9.1729$, $2x-5=13.3458$ $DE=\sqrt{(13.3458)^2+9.1729^2-2(13.3458)(9.1729)\cos 25°}$ $=\sqrt{40.3526}$ =6.35237 =6.35 (3 s.f.)	M2 A1	3
			12
4(a)	Total surface area of bowl $=\pi\times6^2+2\times\pi\times6\times4$ =263.893 =264 cm^2 (nearest cm^2)	M1, M1 A1	3
4(b)(i)	Number of bowls completely filled $=\frac{13l}{(\pi\times6^2\times4)cm^3}$ $=\frac{13\times1000cm^3}{(\pi\times6^2\times4)cm^3}$ =28.7363 =28	M1 M1 A1	3
4(b)(ii)	Volume of soup left $=13l-28\times(\pi\times6^2\times4)$ =333.0984	M1 A1	

No	Description	Marks	Total
	=333 cm^3 (nearest cm^3)		
Or 4(b)(ii)	Volume of soup left $=0.7363\times(\pi\times6^2\times4)$ =333.094 =333 cm^3 (nearest cm^3)	M1 A1	2
4(b)(iii)	Volume of hemisphere pan = 13litres = 13000 cm^3 $\frac{2}{3}\pi r^3=13000$ $r=\sqrt[3]{\frac{13000\times3}{2\times\pi}}$ =18.377 cm =184 mm (nearest mm) or 18.4 cm (nearest mm)	M1 A1	2
4(c)	$\frac{V_2}{V_1}=\left(\frac{2}{3}\right)^3=\frac{8}{27}$ The ratio is 8: 27	B1	1
			11
5(a)	Angle $PQT=180°-63°-75°=42°$ Bearing of S from $Q=90°+42°=132°$	B1 B1	2
5(b)	$\frac{QT}{sin75°}=\frac{45}{sin63°}$ $QT=\frac{45}{sin63°}\times sin75°$ =48.783775 = 48.8 m (3 s.f.)	M1 AG1	2
5(c)	Let shortest distance from ship to cliff be h. $\frac{1}{2}\times h\times45=\frac{1}{2}\times45\times48.783776\times sin42°$ $h=48.783776\times sin42°$ $h=32.642715$ $h=32.6$ m (3 s.f.)	M1 A1	2
Or 5(c)	$\sin 42°=\frac{h}{48.8}$ $h=\sin 42°\times48.8$ =32.654 =32.7 m (3 s.f.)	M1 A1	
5(d)(i)	Let the height of the cliff be H. $\tan 16°=\frac{H}{48.783755}$ $H=\tan 16°\times48.783755$ =13.9883 =14. 0 m (3 s.f.)	Note : if H = tan 16° × 48.8 =13.993 = 14.0m M1 A1	2
5(d)(ii)	Angle of elevation = $\tan^{-1}\left(\frac{13.9883}{32.642715}\right)=23.196°$ =23.2°	M1 note can be FT1 A1	2
			12
6(a)(i)	$p=12$	B1	1
6(a)(ii)	Plot the points Draw a smooth curve	P2 C1	3
6(b)	490 (accept answer: 460 – 500)	B1	1

No	Description	Marks	Total
6(c)(i)	Draw a tangent line Gradient of tangent $= -\frac{20.1}{800} = -0.025125$ $= -0.0251$ (3 s.f.) Accept answers: (-0.023 to – 0.03) Actual answer: –0.02666 = –0.0267	B1 B1 * answer must be a decimal number	2
6(c)(ii)	The gradient represent the rate of decrease of the cost of printing each book when number of books is 300. Or The gradient represent the rate at which the cost of printing each book is decreasing.	B1	1
6(d)(i)	Plot points (0, 25), (600, 15) and (1200, 5) Draw a line	P1 L1	2
6(d)(ii)	$210 \le x \le 700$ (accept 180 – 220; 680 – 730, with interval of 10)	B1	1
7(a)(i)	Angle $APC = 90°$ (tangent perpendicular radius) Angle $AQE = 90°$(tangent perpendicular radius) Therefore, angle APC = angle AQE Angle PAC = Angle QAE (common angle) Since there are two pairs of corresponding angles are equal, triangle APC and triangle AQE are similar.	B1 B1	2
7(a)(ii)	$\frac{AC}{AE} = \frac{PC}{QE}$ $\frac{AB+2}{AB+4+6} = \frac{2}{6}$ $\frac{AB+2}{AB+10} = \frac{1}{3}$ $3(AB+2) = AB+10$ $3AB+6 = AB+10$ $2AB = 4$ $AB = 2$	M1 A1	2
7(b)	Angle EAQ = Angle CAP $\sin\angle CAP = \frac{PC}{AC} = \frac{2}{4} = \frac{1}{2}$ $\angle CAP = \sin^{-1}\left(\frac{1}{2}\right) = 30° = \frac{\pi}{6}$	AG1 (for $\sin^{-1}\left(\frac{1}{2}\right)$)	1
7(c)	Perimeter of the shaded region = Arc PD + PQ + Arc QD $= \frac{120}{360}\times 2\times\pi\times 2 + \sqrt{12^2-6^2} - \sqrt{4^2-2^2} + \frac{60}{360}\times 2\times\pi\times 6$ =4.18879+ 6.92820 + 6.28318 =17.40017 =17.4 cm (3 s.f.) or 17.5 cm (3 s.f.) (if rounded off to 5 s.f. for working)	M1 (Arc $PD = \frac{4}{3}\pi$) M1 ($PQ = 4\sqrt{3}$) M1 (Arc $QD = 2\pi$) A1	4
8(a)(i)(a)	$\overrightarrow{WM} = \overrightarrow{WX} + \overrightarrow{XM} = 6\boldsymbol{p} + 3\boldsymbol{q} + \frac{3}{5}(10\boldsymbol{p} - 5\boldsymbol{q})$ $\overrightarrow{WM} = 12\boldsymbol{p}$	B1	1
8(a)(i)(b)	$\overrightarrow{ZM} = \overrightarrow{ZW} + \overrightarrow{WM}$ $\overrightarrow{ZM} = -10\boldsymbol{p} + 5\boldsymbol{q} + 12\boldsymbol{p}$	Note: If notation is wrong, minus 1 marks for overall (a)(i)	

No	Description	Marks	Total
8(a)(i)(b) OR	$\overrightarrow{ZM} = 2\boldsymbol{p} + 5\boldsymbol{q}$	B1	
	$\overrightarrow{ZM} = \overrightarrow{ZY} + \overrightarrow{YM} = 6\boldsymbol{p} + 3\boldsymbol{q} + \frac{2}{5}(-10\boldsymbol{p} + 5\boldsymbol{q})$ $\overrightarrow{ZM} = 2\boldsymbol{p} + 5\boldsymbol{q}$	B1	1
8(a)(ii)(a)	Area of triangle WMX :area of $WXYZ$ $= \frac{Area\ of\ triangle\ WMX}{Area\ of\ triangle\ WXY} \times \frac{Area\ of\ triangle\ WXY}{Area\ of\ WXYZ}$ $= \frac{3}{5}\times\frac{1}{2} = \frac{3}{10}$ Area of triangle WMX : area of $WXYZ$ = 3 : 10	B1	1
8(a)(ii)(b)	Area of $WXYZ = 8\times\frac{10}{3} = \frac{80}{3}$ units^2 or $26\frac{2}{3}$ or 26.7 (3 s.f)	B1	1
8(a)(iii)	$\overrightarrow{WN} = \frac{5}{2}(6\boldsymbol{p} + 3\boldsymbol{q}) = \frac{15}{2}(2\boldsymbol{p} + \boldsymbol{q})$	B1	1
8(b)(i)	$\overrightarrow{AB} = \begin{pmatrix}3\\-3\end{pmatrix} + \begin{pmatrix}7\\-13\end{pmatrix} = \begin{pmatrix}10\\-16\end{pmatrix}$	B1	1
8(b)(ii)	Acute angle $= \tan^{-1}\left(\frac{16}{10}\right) = 57.994 = 58.0°$ (1 d.p.)	M1 (tan ratio), A1	2
8(b)(iii)	$\overrightarrow{AB} = k\begin{pmatrix}n\\-2m\end{pmatrix}$ or $\overrightarrow{AB} = k\begin{pmatrix}-n\\2m\end{pmatrix}$	B1	1
8(b)(iv)	$\overrightarrow{CD} = 3\overrightarrow{AB} = 3\begin{pmatrix}10\\-16\end{pmatrix} = \begin{pmatrix}30\\-48\end{pmatrix}$ $\overrightarrow{CD} = -3\overrightarrow{AB} = -3\begin{pmatrix}10\\-16\end{pmatrix} = \begin{pmatrix}-30\\48\end{pmatrix}$	B1 B1	2
			9
9(a)(i)	41 minutes	B1	1
9(a)(ii)	25 minutes	B1	1
9(a)(iii)	Q_1 = 29 mins; Q_3 = 48 mins IQR = 48 – 29 = 19 mins	M1, A1 or B2	2
9(a)(iv)	Percentage of adults who spend more than 40 minutes travelling to work everyday $= \frac{120-76}{120}\times 100\% = \frac{44}{120}\times 100\%$ $= 36\frac{2}{3}\%$ *or* $\frac{110}{3}\%$ or 36.7% (3 s.f.)	B1	1
9(b)	Median for bus = 43 mins IQR for bus = 55 – 27 = 28 mins The travelling time using train is much shorter (faster) than using a bus as the median time travelling with a train < median time travelling with a bus. The travelling time using train is less spread out (more consistent) than using travelling using a bus as the interquartile range of travelling time of a train < interquartile range of travelling time of a bus.	B1 for both median and IQR of bus B1 B1	3
9(c)(i)	P(more than 55 minutes) $= \frac{120-106}{120}\times\frac{1}{4} = \frac{14}{120}\times\frac{1}{4} = \frac{7}{240}$	B1	1
9(c)(ii)	P(more than 55 minutes on one trip) $= \frac{120-106}{120}\times\frac{3}{4} + \frac{106}{120}\times\frac{1}{4}$ $= \frac{14}{120}\times\frac{3}{4} + \frac{106}{120}\times\frac{1}{4} = \frac{37}{120}$	M1 A1	2

No	Description	Marks	Total
			11
10(a)(i)	Total distance for Lane 1 $= 2\times\pi\times(36.5+0.3)+(84.39\times2)$ = 400.001 m = 400 m (3 s.f.)	M1 for 36.5 + 0.3 AG1	2
10(a)(ii)	Total distance for Lane 8 $= 2\times\pi\times(36.5+0.2+1.22\times7)+(84.39\times2)$ = 453.031 Staggered start = 453.031 – 400 = 53.03 m (2 d.p.)	M1 for 1.22 × 7 M1 for the formula AG1	3
10(a)(ii)	Total distance for Lane 8 =		
10(a)(iii)	Using staggered start, each runner runs exactly 400 meters or run the same distance.	B1	1
10(b)	Speed = 6.8 km/h = $\frac{6.8\times1000}{1\times60} m/\min$ $= 113\frac{1}{3} m/\min$ Time taken to complete one round in Lane 8 $= \frac{453.031m}{6.8km/h} = \frac{453.031m}{113\frac{1}{3} m/\min}$ =3.99733 mins Time taken to complete five rounds in Lane 8 = 3.99733 × 5 = 19.9866 mins Time taken to complete five rounds in Lane 8 in 1 week = 19.98666 × 7 =138.906 mins (< 150 minutes) His claim in false.	B1 (convert speeds) M1 (time for 1 round) M1 (time taken for 1 week) A1	4
Or 10b	Total distance for average speed of 6.8 km/h = 6.8 km/h × 150 mins = 6.8 km/h × 2.5 hours = 17 km = 17000 m Total distance covered for 5 round for 1 week = 453.03 ×5× 7 =15856.05 m Since 15856.05 m < 17000 m, his claim is false.	B1 M1 for × 5, M1 for × 7 A1	
Or 10b	Total distance for average speed of 6.8 km/h = 6.8 km/h × 150 mins = 6.8 km/h × 2.5 hours = 17 km = 17000 m No. of rounds covered in 1 week = $\frac{17000}{453.03} = 37.525$ rounds No. of round covered in 1 week if he ran 5 rounds in one week = 5× 7 = 35 rounds. Since 35 rounds < 37.525 rounds, his claim is false.	B1 M1 M1 A1	
			10