Solution	Marks	Remarks
1. $\frac{2}{4h-7}-\frac{3}{6h-5}$		
$=\frac{2(6h-5)-3(4h-7)}{(4h-7)(6h-5)}$	1M	
$=\frac{12h-10-12h+21}{(4h-7)(6h-5)}$	1M	
$=\frac{11}{(4h-7)(6h-5)}$	1A	or equivalent
	----------(3)	
2. $\frac{Ax+C}{B}=3x$		
$Ax+C=3Bx$	1M	
$Ax-3Bx=-C$	1M	for putting x on one side
$x=\frac{C}{3B-A}$	1A	or equivalent
$\frac{Ax+C}{B}=3x$		
$\frac{Ax}{B}+\frac{C}{B}=3x$	1M	
$\frac{Ax}{B}-3x=\frac{-C}{B}$	1M	for putting x on one side
$x=\frac{C}{3B-A}$	1A	or equivalent
	----------(3)	
3. (a) $6r^2-13rs-28s^2$		
$=(2r-7s)(3r+4s)$	1A	or equivalent
(b) $4r-14s+6r^2-13rs-28s^2$		
$=4r-14s+(2r-7s)(3r+4s)$	1M	for using the result of (a)
$=2(2r-7s)+(2r-7s)(3r+4s)$		
$=(2r-7s)(2+3r+4s)$	1A	or equivalent
	----------(3)	
4. (a) $\frac{5x+7}{4}-1<2x$		
$5x+7-4<8x$	1M	for putting x on one side
$-3x<-3$	1A	
$x>1$		
$3x+9\geq 0$		
$x\geq -3$	1A	
Thus, the required range is $x>1$.		
(b) 2	1A	
	----------(4)	

Solution	Marks	Remarks
5. $a:c=6:5$	1M	either one
$\frac{2b+7c}{b+c}=4$ $2b+7c=4b+4c$ $2b=3c$ $b:c=3:2$ $b:c=15:10$ $a:c=12:10$		
So, we have $a:b:c=12:15:10$.	1M	
Let $a=12k$, $b=15k$ and $c=10k$, where k is a non-zero constant.		
$\frac{5a+8b}{2b+3c}$ $=\frac{5(12k)+8(15k)}{2(15k)+3(10k)}$	1M	
$=3$	1A ----------(4)	
6. Let $\$x$ be the marked price of the calculator. The cost of the calculator $=\frac{x}{(1+40\%)}$ $=\$\left(\frac{5x}{7}\right)$	1M	
The selling price of the calculator $=(75\%)x$ $=\$\left(\frac{3x}{4}\right)$	1M	
$\frac{3x}{4}-\frac{5x}{7}=13$	1M	
$x=364$ Thus, the marked price of the calculator is $\$364$.	1A	
Let $\$c$ be the cost of the calculator. The marked price of the calculator $=(1+40\%)c$ $=\$1.4c$	1M	
The selling price of the calculator $=(75\%)(1.4c)$ $=\$1.05c$	1M	
$1.05c-c=13$	1M	
$c=260$ Thus, the marked price of the calculator is $\$364$.	1A ----------(4)	

Solution	Marks	Remarks
7. (a) $\angle POQ$		
$= 149° - 59°$		
$= 90°$	1A	
(b) $\angle POR$		
$= 239° - 59°$		
$= 180°$		
Thus, P, O and R are collinear.	1A	f.t.
(c) The required perimeter		
$= PQ + QR + PR$	1M	
$= \sqrt{11^2 + 60^2} + \sqrt{60^2 + 144^2} + (11 + 144)$		
$= 372$	1A	
	----------(4)	
8. (a) $\angle ACB = \angle ADB = 90°$ (given)		
$BC = AD$ (given)		
$AB = AB$ (common side)		
$\Delta ABC \cong \Delta BAD$ (RHS)		
Marking Scheme:		
Case 1 Any correct proof with correct reasons.	2	
Case 2 Any correct proof without reasons.	1	
(b) AE	1M	
$= \sqrt{AD^2 + DE^2}$		
$= 15$ cm		
By (a), we have $\angle ABE = \angle BAE$.	1M	
Hence, we have $AE = BE$.		
So, we have $BE = 15$ cm .		
Note that $CE = DE = 9$ cm .		
The required area		
$= \frac{1}{2}(AD)(BD) + \frac{1}{2}(BC)(CE)$		
$= \frac{1}{2}(12)(9+15) + \frac{1}{2}(12)(9)$	1A	
$= 198\text{ cm}^2$	----------(5)	
	1M	
9. (a) $\frac{4+k}{10+9+4+3+4+k} = \frac{5}{18}$	1A	
$k = 6$	1A	
(b) The mean $= 5$	1A	
The mode $= 3$	1A	
	----------(5)	
The median $= 4$		

Solution	Marks	Remarks
10. (a) Let $g(x) = a + bx$, where a and b are non-zero constants.	1A	
So, we have $a - 3b = -21$ and $a + 7b = 9$.	1M	for either substitution
Solving, we have $a = -12$ and $b = 3$.	1A	for both correct
Thus, we have $g(x) = 3x - 12$.		
	----------(3)	
(b) $h(x) = 0$		
$xg(x) + k = 0$		
$3x^2 - 12x + k = 0$	1M	
Note that all the roots of the equation $h(x) = 0$ are real numbers.		
$(-12)^2 - 4(3)(k) \geq 0$	1M	
$k \leq 12$	1A	
	----------(3)	
11. (a) $\frac{21+32+33+37+39+40+40+b+(20+28+29+30+34)(2)+(20+a)(3)}{20} = 30$	1M	
Therefore, we have $3a + b = 16$.		
Thus, we have $\begin{cases} a = 3 \\ b = 7 \end{cases}$, $\begin{cases} a = 4 \\ b = 4 \end{cases}$ or $\begin{cases} a = 5 \\ b = 1 \end{cases}$.	1A+1A	1A for one pair + 1A for all
	----------(3)	
(b) 21	1A	
	----------(1)	
(c) When $a = 3$, the inter-quartile range of the distribution is the greatest.	1M	
The greatest possible inter-quartile range of the distribution		
$= 34 - 23$	1M	
$= 11$	1A	f.t.
By (a), there are three cases.		
Case 1: $a = 3$		
The inter-quartile range of the distribution		
$= 34 - 23$	1M	any one
$= 11$	1M	any one
Case 2: $a = 4$		
The inter-quartile range of the distribution		
$= 34 - 24$		
$= 10$		
Case 3: $a = 5$		
The inter-quartile range of the distribution		
$= 34 - 25$		
$= 9$		
Thus, the greatest possible inter-quartile range of the distribution is 11 .	1A	f.t.
	----------(3)	

Solution	Marks	Remarks
12. (a) Let $(b, 0)$ be the coordinates of B. Then, the coordinates of A, C and D are $(mb+b, 0)$, (b, mb) and $(mb+b, mb)$ respectively.	1M	for any one
The slope of OD $=\dfrac{mb-0}{mb+b-0}$	1M	
$=\dfrac{m}{m+1}$	1A	
Let k be the slope of OD. Denote the x-coordinate of A by a. Then, the coordinates of D are (a, ka). Therefore, the x-coordinate of B is $a-ka$. So, the coordinates of C are $(a-ka, ka)$.	1M	either one
$ka = m(a-ka)$ $k = m - mk$ $k=\dfrac{m}{m+1}$	1M	
Thus, the slope of OD is $\dfrac{m}{m+1}$.	1A	
	----------(3)	
(b) The slope of OM $=\dfrac{5-0}{6-0}$ $=\dfrac{5}{6}$		
The slope of OQ $=\dfrac{\frac{5}{6}}{\frac{5}{6}+1}$ (by (a)) $=\dfrac{5}{11}$ So, the equation of the straight line passing through O and Q is $y=\dfrac{5x}{11}$.	1M	for using the result of (a)
The equation of the straight line passing through M and N is $y-0=\dfrac{5-0}{6-10}(x-10)$ $y=\dfrac{-5x}{4}+\dfrac{25}{2}$ Solving $y=\dfrac{5x}{11}$ and $y=\dfrac{-5x}{4}+\dfrac{25}{2}$, the coordinates of Q are $\left(\dfrac{22}{3}, \dfrac{10}{3}\right)$.	1M	
The x-coordinate of P	1M	
$=\dfrac{22}{3}-\dfrac{10}{3}$	1A	
$=4$	----------(4)	

Solution	Marks	Remarks
13. (a) The volume of X		
$=\frac{1}{3}(64^2)(24)\left(1-\left(\frac{18}{24}\right)^3\right)$	1M+1M	
$=18\,944\text{ cm}^3$	1A	r.t. $18\,900\text{ cm}^3$
	----------(3)	
(b) The area of each lateral face of X		
$=\frac{1}{2}\left(64+\frac{3}{4}(64)\right)\sqrt{6^2+8^2}$	1M	
$=560\text{ cm}^2$		
The total surface area of X		
$=4(560)+64^2\left(1+\left(\frac{3}{4}\right)^2\right)$	1M	
$=8\,640\text{ cm}^2$		
$\left(\frac{\text{The height of } X}{\text{The height of } Z}\right)^2=\left(\frac{6}{3}\right)^2=4$		
$\frac{\text{The total surface area of } X}{\text{The total surface area of } Z}=\frac{8\,640}{960}=9$		
$\frac{\text{The total surface area of } X}{\text{The total surface area of } Z}\neq\left(\frac{\text{The height of } X}{\text{The height of } Z}\right)^2$	1M	
Thus, X and Z are not similar.	1A	f.t.
	----------(4)	
14. (a) -4	1A	
	----------(1)	
(b) (i) By (a), we have $\mathrm{F}(x)=(6x^2+x-4)(qx^2+rx-10)$.		
Note that $\mathrm{F}(-1)=-12$ and $\mathrm{F}(2)=0$.	1M+1M	
Hence, we have $(6(-1)^2+(-1)-4)(q(-1)^2+r(-1)-10)=-12$		
and $(6(2)^2+(2)-4)(q(2)^2+r(2)-10)=0$.		
So, we have $q-r=-2$ and $2q+r=5$.		
Solving, we have $q=1$ and $r=3$.	1A	for both correct
(ii) $\mathrm{F}(x)=0$		
$(6x^2+x-4)(x^2+3x-10)=0$		
$(6x^2+x-4)(x-2)(x+5)=0$	1M	
$6x^2+x-4=0$, $x-2=0$ or $x+5=0$	1M	
$x=\frac{-1\pm\sqrt{97}}{12}$, $x=2$ or $x=-5$	1M	
Note that $\frac{-1-\sqrt{97}}{12}$ and $\frac{-1+\sqrt{97}}{12}$ are irrational numbers.		
Also note that 2 and -5 are not irrational numbers.		
Thus, the equation $\mathrm{F}(x)=0$ has 2 irrational roots.	1A	f.t.
	----------(7)	

Solution	Marks	Remarks
15. $\log_9 y - 22 = 4(\log_3 x - 5)$	1M	
$\log_9 y = \log_3 x^4 + 2$	1M	any one
$\log_9 y = \log_3 9x^4$		
$\frac{\log_3 y}{\log_3 9} = \log_3 9x^4$		
$\log_3 y = 2\log_3 9x^4$		
$y = 81x^8$	1A	
	----------(3)	
16. (a) The required probability		
$= \frac{C_4^{16} C_1^4}{C_5^{20}}$	1M	for numerator
$= \frac{455}{969}$	1A	r.t. 0.470
The required probability		
$= 5\left(\frac{16}{20}\right)\left(\frac{15}{19}\right)\left(\frac{14}{18}\right)\left(\frac{13}{17}\right)\left(\frac{4}{16}\right)$	1M	for numerator
$= \frac{455}{969}$	1A	r.t. 0.470
	----------(2)	
(b) The required probability		
$= 1 - \frac{C_5^{16}}{C_5^{20}} - \frac{455}{969}$	1M	for $1 - p_1 - $(a)
$= 1 - \frac{91}{323} - \frac{455}{969}$		
$= \frac{241}{969}$	1A	r.t. 0.249
The required probability		
$= \frac{C_3^{16} C_2^4}{C_5^{20}} + \frac{C_2^{16} C_3^4}{C_5^{20}} + \frac{C_1^{16} C_4^4}{C_5^{20}}$	1M	for $p_2 + p_3 + p_4$
$= \frac{70}{323} + \frac{10}{323} + \frac{1}{969}$		
$= \frac{241}{969}$	1A	r.t. 0.249
	----------(2)	

Solution	Marks	Remarks
17. (a) (i) Γ is the perpendicular bisector of QR.	1M	
(ii) The coordinates of the mid-point of QR are $(3,-5)$.		
The slope of QR $=\dfrac{-9-(-1)}{-4-10}$ $=\dfrac{4}{7}$		
The equation of Γ is $y-(-5)=\dfrac{-7}{4}(x-3)$	1M	
$7x+4y-1=0$	1A ----------(3)	or equivalent
(b) (i) Denote the point $(4,3)$ by S. The coordinates of the mid-point of RS are $(0,-3)$.		
The slope of RS $=\dfrac{3-(-9)}{4-(-4)}$ $=\dfrac{3}{2}$		
The equation of the perpendicular bisector of RS is $y-(-3)=\dfrac{-2}{3}(x-0)$ $2x+3y+9=0$		
Solving $7x+4y-1=0$ and $2x+3y+9=0$, the coordinates of the centre of C are $(3,-5)$.	1M	
The radius of C $=\sqrt{(4-3)^2+(3+5)^2}$	1M	
$=\sqrt{65}$		
Thus, the equation of C is $(x-3)^2+(y+5)^2=65$.	1A	$x^2+y^2-6x+10y-31=0$
(ii) Denote the centre of C by G. Note that G lies on the circumcircle of ΔUVW. Also note that GU is a diameter of the circumcircle of ΔUVW.		
GU $=\sqrt{(10-3)^2+(4+5)^2}$ $=\sqrt{130}$		
The area of the circumcircle of ΔUVW $=\pi\left(\dfrac{\sqrt{130}}{2}\right)^2$	1M	
≈ 102.1017612 >100		
Thus, the area of the circumcircle of ΔUVW is greater than 100.	1A ----------(5)	f.t.

Solution	Marks	Remarks
18. (a) (i) By cosine formula, we have		
$QS^2 = PQ^2 + PS^2 - 2(PQ)(PS)\cos\angle QPS$		
$QS^2 = 12^2 + 10^2 - 2(12)(10)\cos 82°$	1M	
$QS \approx 14.51201074$		
$QS \approx 14.5\text{ cm}$		
Thus, the length of QS is 14.5 cm .	1A	r.t. 14.5 cm
(ii) By sine formula, we have		
$\dfrac{\sin\angle QSR}{QR} = \dfrac{\sin\angle QRS}{QS}$	1M	
$\sin\angle QSR \approx \dfrac{13\sin 65°}{14.51201074}$		
$\angle QSR \approx 54.27995332°$ or $\angle QSR \approx 125.7200468°$ (rejected)		
$\angle RQS$		
$\approx 180° - 65° - 54.27995332°$		
$\approx 60.72004668°$		
$\approx 60.7°$	1A	r.t. $60.7°$
	----------(4)	
(b) (i) Denote the foot of the perpendicular from R to QS by T.		
Then, we have $RT = 13\sin\angle RQS$.		
Let h cm be the shortest distance from R to the plane PQS .		
$h = RT\sin 80°$	1M	
$h = (13\sin\angle RQS)\sin 80°$		
By (a)(ii), we have $h \approx 11.16685898$.		
Thus, the required distance is 11.2 cm .	1A	r.t. 11.2 cm
(ii) Denote the shortest distance from P to the plane QRS by d cm .		
$\dfrac{1}{3}(\text{the area of }\Delta PQS)h = \dfrac{1}{3}(\text{the area of }\Delta QRS)d$	1M	
$\dfrac{d}{h} = \dfrac{\frac{1}{2}(PQ)(PS)\sin\angle QPS}{\frac{1}{2}(QR)(QS)\sin\angle RQS}$		
$\dfrac{d}{11.16685898} \approx \dfrac{(12)(10)(\sin 82°)}{(13)(14.51201074)\sin 60.72004668°}$		
$d \approx 8.064136851$		
Since $PX \geq d$, the distance between P and X exceeds 8 cm .	1A	f.t.
Thus, the claim is correct.	----------(4)	

Solution	Marks	Remarks
19. (a) $\mathrm{f}(x)$		
$= 2x^2 + 4mx + 8x + 2m^2 + 8m + n$		
$= 2(x^2 + 2mx + 4x) + 2m^2 + 8m + n$		
$= 2(x^2 + 2(m+2)x + (m+2)^2 - (m+2)^2) + 2m^2 + 8m + n$	1M	
$= 2(x + m + 2)^2 + n - 8$		
Thus, the coordinates of P are $(-m-2, n-8)$.	1A	
	----------(2)	
(b) Transforming $\mathrm{f}(x)$ to $\mathrm{f}\left(\frac{x}{5}\right)+7$ represents the enlargement of 5 times of the original along the x-axis and the upward translation of 7 units.	1A+1A	
	----------(2)	
(c) (i) The coordinates of Q are $(-5m-10, n-1)$.	1M	
Note that $1+n-(-m-2) = -5m-10-(1+n)$ and $\frac{4-m}{n-8} = \frac{n-1}{4-m}$.	1M+1M	
So, we have $n = -3m-7$ and $8m^2 + 77m + 104 = 0$.	1M	for $\alpha u^2 + \beta u + \gamma = 0$
Since $mn < 0$, we have $m = -8$ and $n = 17$.		
Thus, the coordinates of P and Q are $(6, 9)$ and $(30, 16)$ respectively.	1A	for both correct
(ii) For $PQ // SR$, the slope of PQ is equal to the slope of RS .		
Therefore, we have $\frac{t-(2t-3)}{3t+27-(3t+3)} = \frac{16-9}{30-6}$.	1M	
Solving, we have $t = -4$.		
The coordinates of R and S are $(15, -4)$ and $(-9, -11)$ respectively.		
$PQ = \sqrt{(30-6)^2 + (16-9)^2} = 25$	1M	any one
$RS = \sqrt{(15-(-9))^2 + (-4-(-11))^2} = 25$		
$QR = \sqrt{(30-15)^2 + (16-(-4))^2} = 25$		
When $t = -4$, we have $PQ = QR = RS$ and $PQ // SR$.		
Thus, it is possible that $PQRS$ is a rhombus.	1A	f.t.
For $PQ = RS$, we have		
$\sqrt{(30-6)^2 + (16-9)^2} = \sqrt{((3t+27)-(3t+3))^2 + (t-(2t-3))^2}$.	1M	
Simplifying, we have $t^2 - 6t - 40 = 0$.		
Solving, we have $t = 10$ or $t = -4$.		
Case 1: $t = 10$		
The coordinates of R and S are $(57, 10)$ and $(33, 17)$ respectively.		
$QR = \sqrt{(57-30)^2 + (10-16)^2} = \sqrt{765} \neq 25 = PQ$	1M	any one
Hence, $PQRS$ is not a rhombus.		
Case 2: $t = -4$		
The coordinates of R and S are $(15, -4)$ and $(-9, -11)$ respectively.		
$QR = \sqrt{(30-15)^2 + (16-(-4))^2} = 25$		
$PS = \sqrt{(6-(-9))^2 + (9-(-11))^2} = 25$		
When $t = -4$, we have $PQ = QR = RS = PS$.		
Thus, it is possible that $PQRS$ is a rhombus.	1A	f.t.

Solution	Marks	Remarks
For $PQ=QR$, we have		
$\sqrt{(30-6)^2+(16-9)^2}=\sqrt{(3t+27-30)^2+(t-16)^2}$.	1M	
Simplifying, we have $t^2-5t-36=0$.		
Solving, we have $t=9$ or $t=-4$.		
Case 1: $t=9$		
The coordinates of R and S are $(54,9)$ and $(30,15)$ respectively.		
$RS=\sqrt{(54-30)^2+(9-15)^2}=\sqrt{612}\neq 25=PQ$	1M	any one
Hence, $PQRS$ is not a rhombus.		
Case 2: $t=-4$		
The coordinates of R and S are $(15,-4)$ and $(-9,-11)$ respectively.		
$RS=\sqrt{(15-(-9))^2+(-4-(-11))^2}=25$		
$PS=\sqrt{(6-(-9))^2+(9-(-11))^2}=25$		
When $t=-4$, we have $PQ=QR=RS=PS$.		
Thus, it is possible that $PQRS$ is a rhombus.	1A	f.t.
For $QR=RS$, we have		
$\sqrt{(3t+27-30)^2+(t-16)^2}=\sqrt{(3t+27-3t-3)^2+(t-2t+3)^2}$.	1M	
Simplifying, we have $9t^2-44t-320=0$.		
Solving, we have $t=\frac{80}{9}$ or $t=-4$.		
Case 1: $t=\frac{80}{9}$		
The coordinates of R and S are $\left(\frac{161}{3},\frac{80}{9}\right)$ and $\left(\frac{89}{3},\frac{133}{9}\right)$ respectively.		
$PS=\sqrt{\left(6-\frac{89}{3}\right)^2+\left(9-\frac{133}{9}\right)^2}=\sqrt{\frac{48\,073}{81}}\neq 25=PQ$	1M	any one
Hence, $PQRS$ is not a rhombus.		
Case 2: $t=-4$		
The coordinates of R and S are $(15,-4)$ and $(-9,-11)$ respectively.		
$RS=\sqrt{(15-(-9))^2+(-4-(-11))^2}=25$		
$PS=\sqrt{(6-(-9))^2+(9-(-11))^2}=25$		
When $t=-4$, we have $PQ=QR=RS=PS$.		
Thus, it is possible that $PQRS$ is a rhombus.	1A ----------(8)	f.t.

Paper 2

Question No.	Key	Question No.	Key
1.	C (86)	26.	B (55)
2.	D (78)	27.	D (45)
3.	A (88)	28.	C (60)
4.	A (91)	29.	B (87)
5.	B (93)	30.	D (55)
6.	A (77)	31.	B (70)
7.	B (46)	32.	A (63)
8.	D (55)	33.	B (49)
9.	C (67)	34.	D (54)
10.	B (70)	35.	A (34)
11.	C (58)	36.	C (46)
12.	A (73)	37.	C (41)
13.	C (74)	38.	B (47)
14.	A (67)	39.	A (49)
15.	D (68)	40.	C (46)
16.	D (55)	41.	A (27)
17.	C (36)	42.	C (66)
18.	C (82)	43.	D (59)
19.	D (51)	44.	D (72)
20.	D (46)	45.	B (53)
21.	B (36)		
22.	B (64)		
23.	A (56)		
24.	A (59)		
25.	C (40)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.