香港考試及評核局
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數學 試卷一
MATHEMATICS PAPER 1

Hong Kong Certificate of Education Examination
Mathematics Paper 1

General Marking Instructions

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates will have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct answer merits ***all the marks*** allocated to that part, unless a particular method has been specified in the question. Makers should be patient in marking alternative solutions not specified in the marking scheme.

2. In the marking scheme, marks are classified into the following three categories:

'M' marks	awarded for correct methods being used;
'A' marks	awarded for the accuracy of the answers;
Marks without 'M' or 'A'	awarded for correctly completing a proof or arriving at an answer given in a question.

In a question consisting of several parts each depending on the previous parts, 'M' marks should be awarded to steps or methods correctly deduced from previous answers, even if these answers are erroneous. However, 'A' marks for the corresponding answers should NOT be awarded (unless otherwise specified).

3. For the convenience of markers, the marking scheme was written as detailed as possible. However, it is still likely that candidates would not present their solution in the same explicit manner, e.g. some steps would either be omitted or stated implicitly. In such cases, markers should exercise their discretion in marking candidates' work. In general, marks for a certain step should be awarded if candidates' solution indicated that the relevant concept/technique had been used.

4. Use of notation different from those in the marking scheme should not be penalized.

5. In marking candidates' work, the benefit of doubt should be given in the candidates' favour.

6. Marks may be deducted for wrong units (*u*) or poor presentation (*pp*).
   a. The symbol *u-1* should be used to denote 1 mark deducted for *u*. At most deduct ***1 mark*** for *u* in Section A. Do not deduct any marks for *u* in Section B.
   b. The symbol *pp-1* should be used to denote 1 mark deducted for *pp*. At most deduct ***1 mark*** for *pp* in each of Section A and Section B. For similar *pp*, deduct 1 mark for the first time that it occurs. Do not penalize candidates twice in the paper for the same *pp*.
   c. At most deduct 1 mark in each question. Deduct the mark for *u* first if both marks for *u* and *pp* may be deducted in the same question.
   d. In any case, do not deduct any marks for *pp* or *u* in those steps where candidates could not score any marks.

7. Marks entered in the Page Total Box should be the NET total scored on that page.

8. In the marking scheme, 'r.t.' stands for 'accepting answers which can be rounded off to', 'f.t.' stands for 'follow through' and 'or equivalent' means 'accepting equivalent forms of the equation which has been simplified and without uncollected like terms'. Steps which can be skipped are shaded whereas alternative answers are enclosed with rectangles. All fractional answers must be simplified.

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Solution	Marks	Remarks
1. $P = ab + 2bc + 3ac$		
$ab + 3ac = P - 2bc$	1M	for putting a on one side
$a(b+3c) = P - 2bc$	1M	for factorization
$a = \frac{P-2bc}{b+3c}$	1A	or equivalent
	----------(3)	
2. $\frac{(x^3y)^2}{y^5}$		
$= \frac{x^6y^2}{y^5}$	1M	for $(ab)^n = a^nb^n$ or $(a^m)^n = a^{mn}$
$= \frac{x^6}{y^{5-2}}$	1M	for $\frac{b^m}{b^n} = b^{m-n}$ or $\frac{b^m}{b^n} = \frac{1}{b^{n-m}}$
$= \frac{x^6}{y^3}$	1A	
	----------(3)	
3. (a) $4x^2 - 4xy + y^2$		
$= (2x-y)^2$	1A	or equivalent
(b) $4x^2 - 4xy + y^2 - 2x + y$		
$= (2x-y)^2 - 2x + y$ (by (a))	1M	for using the result of (a)
$= (2x-y)^2 - (2x-y)$		
$= (2x-y)(2x-y-1)$	1A	or equivalent
	----------(3)	
4. $\frac{-3x+1}{4} > x - 5$		
$-3x + 1 > 4x - 20$		
$-7x > -21$	1M	for putting x on one side
$7x < 21$		
$x < 3$	1A	
For $2x + 1 \geq 0$, we have $x \geq \frac{-1}{2}$.		
Therefore, the solution of $\frac{-3x+1}{4} > x - 5$ and $2x + 1 \geq 0$ is $\frac{-1}{2} \leq x < 3$.		
Thus, all integers which satisfy both the inequalities $\frac{-3x+1}{4} > x - 5$ and $2x + 1 \geq 0$ are 0 , 1 and 2 .	1A	
	----------(3)	

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Solution	Marks	Remarks
5. $n-18=\frac{2n}{5}+18$	1A+1M	1A for $\frac{2n}{5}$ + 1M for equating
$\frac{3n}{5}=36$		
$n=60$	1A	
Suppose that Susan and Teresa have $5k$ marbles and $2k$ marbles respectively.	1A	for $5k$ and $2k$ pp−1 for any undefined symbol
$5k-18=2k+18$	1M	for equating
$3k=36$		
$k=12$		
$n=5k$		
$n=60$	1A	
	----------(3)	
6. (a) Let $\$x$ be the marked price of the calculator. Then, we have		
$x=160(1+25\%)$	1A	
$x=200$	1A	
Thus, the marked price of the calculator is $\$200$.		u−1 for missing unit
Let $\$x$ be the marked price of the calculator. Then, we have		
$\left(\frac{x-160}{160}\right)(100\%)=25\%$	1A	accept without 100%
$x-160=40$		
$x=200$	1A	
Thus, the marked price of the calculator is $\$200$.		u−1 for missing unit
(b) The selling price of the calculator		
$=200(90\%)$	1M	for (a)(90%)
$=\$180$		
The percentage profit		
$=(\frac{180-160}{160})(100\%)$		
$=12.5\%$	1A	
The selling price of the calculator		
$=200(90\%)$	1M	for (a)(90%)
$=\$180$		
The percentage profit		
$=(\frac{180-160}{200-160})(25\%)$		
$=12.5\%$	1A	
	----------(4)	
7. The common difference = 8−5 = 3	1A	can be absorbed
$\frac{n}{2}((2)(5)+(n-1)(3))=3\,925$	1M	for $\frac{n}{2}((2)(5)+(n-1)(d))=3\,925$
$3n^2+7n-7\,850=0$	1M	in the form $k_1n^2+k_2n+k_3=0$ where $k_1\neq 0$
$n=50$ or $n=\frac{-157}{3}$ (rejected since n is a positive integer)	1A	
Thus, we have $n=50$.		
	----------(4)	

Solution	Marks	Remarks
8. $x=\frac{180(6-2)}{6}$		
$=120$	1A	u–1 for having unit
$y=\frac{180-x}{2}$		
$=\frac{180-120}{2}$	1M	
$=30$	1A	u–1 for having unit
$z=180-2y$		
$=180-(2)(30)$	1M	
$=120$	1A	u–1 for having unit
$z=(180)(5-2)-2x-2(x-y)$		
$=540-4x+2y$		
$=540-(4)(120)+(2)(30)$	1M	
$=120$	1A	u–1 for having unit
	----------(5)	
9. (a) $2\pi(OA)(\frac{100}{360})=10\pi$	1M	for $\frac{100}{360}$
$OA=18$ cm	1A	u–1 for missing unit
$(OA)(\frac{100\pi}{180})=10\pi$	1M	for $\frac{100\pi}{180}$
$OA=18$ cm	1A	u–1 for missing unit
(b) The area of sector $OABC$		
$=\frac{100}{360}\pi(18)^2$	1M	for $\frac{100}{360}\pi(\text{a})^2$
$\approx 282.7433388\text{ cm}^2$		
The area of ΔOAC		
$=\frac{1}{2}(18)^2\sin 100°$	1M	for $\frac{1}{2}(\text{a})^2\sin 100°$
$\approx 159.538856\text{ cm}^2$		
The required area		
$\approx 282.7433388-159.538856$		
≈ 123.2044828		
$\approx 123\text{ cm}^2$	1A	u–1 for missing unit r.t. 123 cm^2
The area of sector $OABC$		
$=\frac{1}{2}(18)^2(\frac{100}{180}\pi)$	1M	for $\frac{1}{2}(\text{a})^2(\frac{100}{180}\pi)$
$\approx 282.7433388\text{ cm}^2$		
The area of ΔOAC		
$=\frac{1}{2}(2(18\sin 50°))(18\cos 50°)$	1M	for $\frac{1}{2}(2((\text{a})\sin 50°))((\text{a})\cos 50°)$
$\approx 159.538856\text{ cm}^2$		
The required area		
$\approx 282.7433388-159.538856$		
≈ 123.2044828		
$\approx 123\text{ cm}^2$	1A	u–1 for missing unit r.t. 123 cm^2
	----------(5)	

Solution	Marks	Remarks
10. (a) Let $f(x) = ax^3 + bx$, where a and b are non-zero constants.	1A	
Since $f(2) = -6$, we have $8a + 2b = -6$ $4a + b = -3$ .... (1) Since $f(3) = 6$, we have $27a + 3b = 6$ $9a + b = 2$ .... (2)	1M	for substitution (either one)
Solving (1) and (2), we have	1M	for solving simultaneous equations and can be absorbed
$\begin{cases} a = 1 \\ b = -7 \end{cases}$	1A	for both correct
Thus, we have $f(x) = x^3 - 7x$.	----------(4)	
(b) (i) $g(x) = f(x) - 6$ $g(3) = f(3) - 6 = 6 - 6 = 0$ Thus, by Factor Theorem, $x - 3$ is a factor of $g(x)$.	1A	
$g(x) = x^3 - 7x - 6$ $g(3) = 3^3 - 7(3) - 6 = 0$ Thus, by Factor Theorem, $x - 3$ is a factor of $g(x)$.	1A	accept using division correctly
(ii) $g(x) = (x-3)(x^2 + 3x + 2)$	1M+1A	1M for $(x-3)(ax^2 + bx + c)$
$= (x-3)(x+1)(x+2)$	1A ----------(4)	

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Solution	Marks	Remarks
11. (a) The required probability		
$=\frac{1}{2}$	1A	0.5
	----------(1)	
(b) The required probability		
$=\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$	1M	for $(a)p_1p_2$, $0<p_1, p_2<1$
$=\frac{1}{8}$	1A	0.125
	----------(2)	
(c) The required probability		
$=\left(1-\frac{1}{2}\right)+\left(\frac{1}{2}\right)\left(1-\frac{1}{2}\right)$	1M+1M	1M for $(1-(a))$ +1M for $(a)p_3$, $0<p_3<1$
$=\frac{3}{4}$	1A	0.75
The required probability		
$=1-\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$	1M+1M	1M for $(1-p_3)$ +1M for $p_3=(a)p_4$, $0<p_3, p_4<1$
$=\frac{3}{4}$	1A	0.75
	----------(3)	
(d) The required probability		
$=\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$	1M	for $(a)p_4\left(\frac{1}{2}\right)$, $0<p_4<1$
$=\frac{1}{8}$	1A	0.125
	----------(2)	

Solution	Marks	Remarks
12. (a) Since the volume of the right circular cone is equal to the volume of the hemisphere, we have		
$\frac{1}{3}\pi(h-4)^2h=\frac{2}{3}\pi(h-4)^3$	1M+1M	1M for $\frac{\pi}{3}r^2h$ + 1M for $\frac{2}{3}\pi r^3$
$h=2(h-4)$ $(\because\ h\neq 4)$		
$h=8$	1A	u–1 for having unit
	----------(3)	
(b) The length of the slant edge of the right circular cone		
$=\sqrt{8^2+4^2}$	1M	for $\sqrt{(a)^2+((a)-4)^2}$
$=\sqrt{80}$		
$=4\sqrt{5}$ cm		
The total surface area of the solid		
= the curved surface area of the cone + the surface area of the hemisphere		
$=\pi(4)(4\sqrt{5})+2\pi(4^2)$	1M	for $\pi((a)-4)l+2\pi((a)-4)^2$
$=16(\sqrt{5}+2)\pi$		
≈ 212.9280006		
≈ 213 cm^2	1A	u–1 for missing unit
	----------(3)	
(c) The increase in the total surface area		
$=2\left(\frac{(8)(8)}{2}+\frac{\pi(4^2)}{2}\right)$	1M	for $\left(\frac{(a)(2(a)-8)}{2}+\frac{\pi((a)-4)^2}{2}\right)$
≈ 114.2654825		
≈ 114 cm^2	1A	u–1 for missing unit
	----------(2)	

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Solution	Marks	Remarks
13. (a) Putting $y=0$ in $2x-y+4=0$, we have $x=-2$.		
Thus, the coordinates of A are $(-2, 0)$.	1A	pp−1 for missing '(' or ')'
Putting $x=0$ in $2x-y+4=0$, we have $y=4$.		
Thus, the coordinates of B are $(0, 4)$.	1A	pp−1 for missing '(' or ')'
	----------(2)	
(b) $\because$ the slope of L_1 is 2.		
$\therefore$ the slope of L_2 is $\frac{-1}{2}$.	1M	can be absorbed
Thus, the equation of L_2 is		
$y=\frac{-x}{2}+4$	1M+1A	1M for slope-intercept form or point-slope form + 1A or equivalent
$x+2y-8=0$		
	----------(3)	
(c) Putting $y=0$ in $x+2y-8=0$, we have $x=8$.	1M	for finding the coordinates of C
So, the coordinates of C are $(8, 0)$.		
Therefore, we have $OC:AC=4:5$.	1A	can be absorbed
The required ratio		
$=4^2:(5^2-4^2)$	1M	for $OC^2:(AC^2-OC^2)$
$=16:9$	1A	accept $1:s$ and $t:1$ with s r.t. 0.563 and t r.t. 1.78
Putting $y=0$ in $x+2y-8=0$, we have $x=8$.	1M	for finding the coordinates of C
So, the coordinates of C are $(8, 0)$.		
Let the coordinates of D be (a, b). Then, we have		
$b=2a$ and $a+2b-8=0$.		
Solving, the coordinates of D are $(1.6, 3.2)$.	1A	can be absorbed
The area of ΔODC		
$=\frac{(8)(3.2)}{2}$		
$=12.8$		
The area of ΔABC		
$=\frac{(10)(4)}{2}$		
$=20$		
The required ratio		
$=12.8:(20-12.8)$	1M	
$=12.8:7.2$		
$=16:9$	1A	accept $1:s$ and $t:1$ with s r.t. 0.563 and t r.t. 1.78
Let the coordinates of D be (a, b). Then, we have		
$b=2a$ and $a+2b-8=0$.		
Solving, the coordinates of D are $(1.6, 3.2)$.	1A	can be absorbed
$OD^2=(1.6)^2+(3.2)^2=12.8$ and $AB^2=2^2+4^2=20$	1M	for either one
The required ratio		
$=12.8:(20-12.8)$	1M	
$=16:9$	1A	accept $1:s$ and $t:1$ with s r.t. 0.563 and t r.t. 1.78
	----------(4)	

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Solution	Marks	Remarks
14. (a) $\sin 30° = \dfrac{BE}{120}$		
$BE = 60$ cm	1A	
$\cos 30° = \dfrac{CE}{120}$		
$CE = 60\sqrt{3}$ cm	1A	r.t. 104 cm $CE \approx 103.9230485$ cm
	----------(2)	
(b) By sine formula, we have		
$\dfrac{AB}{\sin 40°} = \dfrac{120}{\sin 60°}$ and $\dfrac{AC}{\sin 80°} = \dfrac{120}{\sin 60°}$	1M	for either one
$AB \approx 89.06726388$ and $AC \approx 136.4589651$		
$AB \approx 89.1$ cm and $AC \approx 136$ cm	1A+1A	AB r.t. 89.1 cm AC r.t. 136 cm
	----------(3)	
(c) $CD = \sqrt{AC^2 - AD^2}$		
$CD \approx \sqrt{136.4589651^2 - 100^2}$	1M	
$CD \approx 92.84960504$ cm		
$DE = \sqrt{AB^2 - (AD - BE)^2}$		
$DE \approx \sqrt{89.06726388^2 - (100-60)^2}$ (by (a))	1M	for $\sqrt{AB^2 - (100 - BE)^2}$
$DE \approx 79.58000688$ cm		
By cosine formula, we have		
$\cos \angle CDE = \dfrac{DE^2 + CD^2 - CE^2}{2DE \cdot CD}$		
$\cos \angle CDE \approx \dfrac{79.58000688^2 + 92.84960504^2 - (60\sqrt{3})^2}{2(79.58000688)(92.84960504)}$ (by (a))	1M	
$\angle CDE \approx 73.67434913°$		
$\angle CDE \approx 73.7°$	1A	r.t. 73.7°
The required distance		
$= CD \sin \angle CDE$		
$\approx 92.84960504 \sin 73.67434913°$	1M	
≈ 89.10586658		
≈ 89.1 cm	1A	r.t. 89.1 cm
Let x cm be the shortest distance from C to DE. Then, we have		
$\dfrac{1}{2}(x)(DE) = \dfrac{1}{2}(CD)(DE)\sin \angle CDE$		
$x = CD \sin \angle CDE$		
$x \approx 92.84960504 \sin 73.67434913°$	1M	
$x \approx 89.10586658$		
$x \approx 89.1$	1A	r.t. 89.1
Thus, the required distance is 89.1 cm .		
	----------(6)	

Solution	Marks	Remarks
15. (a) The mean		
$= 122$ marks	1A	
The mean deviation		
$= \dfrac{38+36+32+29+22+19+(3)(2)+1+(2)(12)+14+15+22+(3)(24)+36}{20}$	1M	
$= 18.3$ marks	1A	
The standard deviation		
$= 22$ marks	1A	
	----------(4)	
(b) The total number of the top 20% students in the music test		
$= (20)(20\%)$		
$= 4$	1A	can be absorbed
The least score for the top 20% students in the music test		
$= 146$ marks		
The score obtained by Mary		
$= 122 + (22)(1)$	1M	
$= 144$		
< 146		
Thus, Mary is not one of the top 20% students in the music test.	1A	must show reasons
The total number of the top 20% students in the music test		
$= (20)(20\%)$		
$= 4$	1A	can be absorbed
The least score for the top 20% students in the music test		
$= 146$ marks		
The standard score of the least score for the top 20% students in the music test		
$= \dfrac{146-122}{22}$	1M	
$= \dfrac{12}{11}$		
> 1		
Thus, Mary is not one of the top 20% students in the music test.	1A	must show reasons
	----------(3)	
(c) (i) The required probability		
$= \dfrac{1}{20}$	1A	0.05
(ii) The required probability		
$= 2\left((\frac{1}{20})(\frac{1}{19}) + (\frac{1}{20})(\frac{1}{19})\right)$	1M + 1M	1M for $(\frac{1}{n})(\frac{1}{n-1})$ where $n \geq 10$ + 1M for the four cases
$= \dfrac{1}{95}$	1A	r.t. 0.0105
	----------(4)	

Solution	Marks	Remarks
16. (a) (i) The required interest		
$=(200\,000)(\frac{6\%}{12})$		
$=\$1\,000$	1A	
(ii) The required amount		
$=200\,000+1\,000-x$	1M	
$=\$(201\,000-x)$	1A	pp−1 for missing '(' or ')'
(iii) The required amount		
$=200\,000\,(1+\frac{6\%}{12})^n-x(1+\frac{6\%}{12})^{n-1}-x(1+\frac{6\%}{12})^{n-2}-\cdots-x$	1A	
$=200\,000\,(1.005)^n-x\,[(1.005)^{n-1}+(1.005)^{n-2}+\cdots+1]$		
$=200\,000\,(1.005)^n-x\left[\frac{(1.005)^n-1}{1.005-1}\right]$	1M	for sum of GP
$=\$\left\{200\,000(1.005)^n-200x[(1.005)^n-1]\right\}$	1	pp−1 for missing '(', ')', '[', ']', '{' or '}'
	----------(6)	
(b) (i) Assume that Peter has not yet fully repaid the loan after paying the nth instalment but the loan is fully repaid after Peter has paid the $(n+1)$th instalment. Then, by (a)(iii),		
$0<200\,000(1.005)^n-(200)(1\,800)[(1.005)^n-1]\le\frac{1\,800}{1+\frac{6\%}{12}}$	1M	accept either inequality
$360\,000\le 160\,000\,(1.005)^{n+1}<360\,000(1.005)$		
$2.25\le(1.005)^{n+1}<2.26125$		
$\frac{\log(2.25)}{\log(1.005)}\le n+1<\frac{\log(2.26125)}{\log(1.005)}$	1M	for taking log
$162.5911713\le n+1<163.5911713$		
Thus, the required number of the months is 163.	1A	
Let the required time be n months. By (a)(iii), we have		
$200\,000(1.005)^n-(200)(1\,800)[(1.005)^n-1]\le 0$	1M	accept using (a)(iii) = 0
$360\,000\le 160\,000\,(1.005)^n$		
$(1.005)^n\ge\frac{9}{4}$		
$n\ge\frac{\log(2.25)}{\log(1.005)}$	1M	for taking log
$n\ge 162.5911713$		
Thus, the required number of the months is 163.	1A	
(ii) By (a)(i), the monthly instalment of $\$900$ is less than the loan interest of $\$1\,000$ for the 1st month.	1M	for comparing the result of (a)(i)
Therefore, the loan can never be fully repaid.	1A	
Thus, the bank refuses his request.		
If the loan can be fully repaid in m months, then by (a)(iii),		
$200\,000(1.005)^m-(200)(900)[(1.005)^m-1]\le 0$		
$180\,000\le -20\,000\,(1.005)^m$		
which has no solution.	1M	for mentioning no solution
Therefore, the loan can never be fully repaid.	1A	
Thus, the bank refuses his request.		
	----------(5)	

Solution	Marks	Remarks
17. (a) (i) Note that $\angle QRP = 90°$ ($\angle$ in semi-circle)		[半圓上的圓周角]
In ΔOQR and ΔORP,		
$\because \angle QRO = 90° - \angle PRO$		
$\angle RPO = 90° - \angle PRO$ ($\angle$ sum of Δ)		[Δ內角和]
$\therefore \angle QRO = \angle RPO$		
$\angle QOR = 90° = \angle ROP$ (given)		[已知]
$\angle OQR = \angle ORP$ ($\angle$ sum of Δ)		[Δ內角和]
Therefore, $\Delta OQR \sim \Delta ORP$ (AAA)		[等角] (AA) (equiangular)
So, we have $\frac{OR}{OQ} = \frac{OP}{OR}$.		
Thus, we can conclude that $OR^2 = OP \cdot OQ$.		
Marking Scheme :		
Case 1 Any correct proof with correct reasons.	3	
Case 2 Any correct proof without reasons.	2	
Case 3 Incomplete proof with any one correct step and one correct reason.	1	
(ii) In ΔMON and ΔPOR,		
$\angle MNO = \angle PRO$ ($\angle$s in the same segment)		[同弓形內的圓周角] [對同弧的圓周角]
$\because \angle MON = 90°$ ($\angle$ in semi-circle)		[半圓上的圓周角]
$\angle POR = 90°$ (given)		[已知]
$\therefore \angle MON = \angle POR$		
$\angle OMN = \angle OPR$ ($\angle$ sum of Δ)		[Δ內角和]
Therefore, $\Delta MON \sim \Delta POR$ (AAA)		[等角] (AA) (equiangular)
Marking Scheme :		
Case 1 Any correct proof with correct reasons.	2	
Case 2 Any correct proof without reasons.	1	
	----------(5)	
(b) (i) By (a)(i), we have $OR^2 = OP \cdot OQ$		
$OR^2 = (4)(9)$		
$OR = 6$		
Thus, the coordinates of R are $(0, 6)$.	1A	pp−1 for missing '(' or ')'
(ii) Note that $PR = \sqrt{4^2 + 6^2} = \sqrt{52} = 2\sqrt{13}$.	1M	
By (a)(ii), we have $\frac{MN}{2\sqrt{13}} = \frac{\frac{3\sqrt{13}}{2}}{6}$.	1M	
Therefore, we have $MN = \frac{13}{2}$.		
Hence, the radius of the circle $MONR$ is $\frac{13}{4}$.	1A	3.25
Let the coordinates of the centre of the circle $MONR$ be (a, b). Then, we have		
$b = \frac{OR}{2} = \frac{6}{2} = 3$ and	1M	
$a = -\sqrt{(\frac{13}{4})^2 - 3^2} = \frac{-5}{4}$.	1A	−1.25
So, the coordinates of the centre of the circle $MONR$ are $(\frac{-5}{4}, 3)$.		pp−1 for missing '(' or ')'
	----------(6)	